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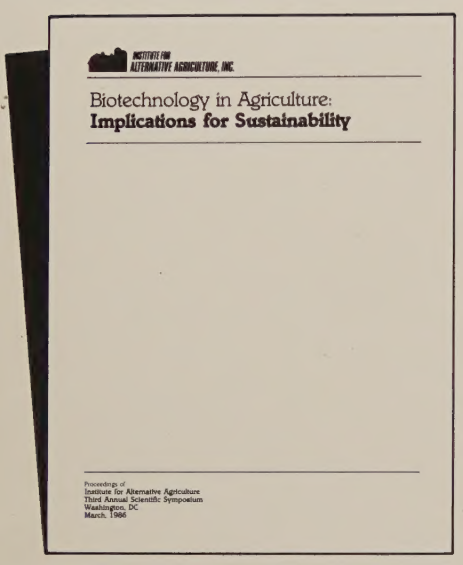

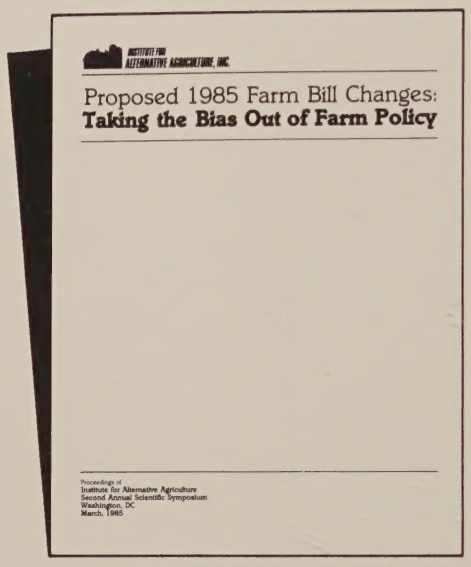

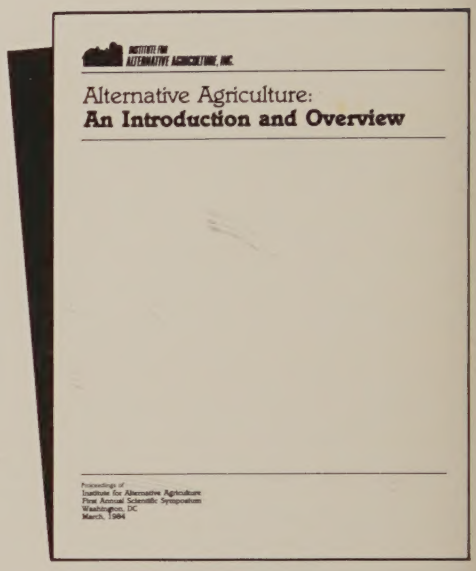

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Institute Information

The Institute for Alternative Agriculture is a nonprofit, tax-exempt research and education organization established in 1983 to encourage and facilitate the adoption of low-cost, resource-conserving and environmentally-sound farming methods. It works closely with producer groups, public research and education institutions, and government agencies in promoting a sustainable agriculture system.

Its programs include providing a national information clearinghouse, serving as a voice for sustainable agriculture in Washington, and developing and implementing research and educational outreach programs. It holds an annual scientific symposium and publishes a monthly newsletter.

The Institute is governed by a 12-member Board of Directors, which includes several commercial-scale organic farmers, and maintains a small professional staff. It is supported by memberships and donations and grants from foundations, corporations, and individuals.

Cover Photo

The program of the first alternative farming field day at North Carolina State University June 25-26 included a stop in Chatham County at Ayshire Farm, a raised-bed organic vegetable partnership operated by Bill Dow and Laurie Heise.

OPINION

More support is needed for alternative agriculture information programs

The difficulty farmers have in getting reliable information on alternative farming methods from Extension and other traditional sources remains a serious problem in American agriculture. Extension workers are getting a lot more questions about alternative production methods and often don't know where to go to get reliable information.

This information gap was an important concern identified in the 1980 U.S. Department of Agriculture report on organic farming. USDA officials admitted in the late 1970s that they were receiving increasing numbers of requests for information and advice on organic farming practices and were unprepared to handle them. Little has changed since then.

Information on alternative agriculture still moves slowly, when it moves at all, through traditional channels. This problem persists even though more research is being done, the scientific literature on alternative agriculture is expanding, and more farmers are asking for information on alternative methods.

The usual way of dealing with an agriculture information gap is to turn to Extension for help. The USDA report, in fact, recommended developing information materials for county Extension agents "to assist them in providing services needed by organic farmers." Some progress has been made in Extension and elsewhere but budget cuts and personnel layoffs, among other things, are making these gains more difficult.

Congress finally responded to this 1980 recommendation in the 1985 farm bill by adopting an agricultural productivity subtitle that authorizes USDA to spend money to disseminate this kind of information. But no money has been provided for implementation of the productivity subtitle and the outlook for a startup appropriation is not good.

New developments

There are some new developments, however, that should help get more of this information moving through traditional channels. The Ruth Mott Fund, for example, has provided funding to enable the Institute for Alternative Agriculture to publish a special edition of its monthly newsletter for Extension agents and specialists for one year. It will provide information on research reports and other published resources, on field d and other alternative agriculture events, and on educati initiatives by land grant universities and other institution will include details on how to follow-up on these various sou for additional and more specific information.

The National Center for Appropriate Technology's effo get money from Congress for a proposed technology tran center has cleared the first hurdle. Authority for this information dissemination approach was included in the 1 farm bill and the House has included $500,000 for a mo startup in its version of the USDA appropriations bill for Fi 1987. The center would disseminate information on cost- ting, resource-conserving agricultural technologies to Exten agents and others.

Another developing source of information is the alterna agriculture tours, field days, and workshops that are be presented by land grant universities, the Regenerative A culture Association, state organic farming groups, and oth They give scientists an opportunity to report on research alternative methods. They also provide organic farmer chance to share information on how they make alterna methods work on the farm.

Insufficient progress

These developments are important breakthroughs in the l term effort to get information out to those who want it. they are no substitute for having information on alterna agriculture routinely available through the same publicly- ported channels that bring farmers the latest farm chem recommendations.

This effort should continue until every farmer who wa reliable information on low-input resource-conserving meth can go to the local Extension office and other traditional sou of agricultural information and get help. This flow of reli information is crucial if alternative agriculture methods ever going to become a genuine option for all of Ameri farmers.

The transition to organic agriculture: A multi-year simulation model of a Pennsylvania farm

Stephan Dabbert and Patrick Madden

Abstract. *Prior research has shown that an established organic farm can be as profitable as a conventional farm under certain circumstances. However, organic farming systems often require a transition period before they are fully established after a change-over from conventional farming. Yields may decrease and recover only slowly during this transition period and less profitable crop rotations may be required to establish an organic system. Previous studies have ignored the income trend during the transition phase, and comparisons of organic and conventional farms have been faulted for lack of similarity in management and other resources. The study reported here used a multi-year simulation model to investigate the trend in income of a 117-hectare crop-livestock farm in Pennsylvania (called the Kutztown farm) during this transition process. A baseline model of the Kutztown farm under conventional management (CONB) was found to earn an income (returns over cash operating cost) of $61,900. The transitional models developed were an upper-yield case assuming no yield decline during the transition (TRANS) and a lower-yield case assuming severe yield decline in the first year after the change-over from conventional management and a subsequent linear recovery of yields over a three-year period (TRANS-L). Income was found to be severely depressed by a yield decline during the transitional phase. The first year of TRANS-L resulted in a 43% reduction in income. The scenario without a yield decline (TRANS) resulted in a 13% lower income compared to the baseline (CONB) model. Both transitional models led to an established organic situation with stable organic yields and an income of $57,400 or 7% less than under conventional management. It was found to be more profitable to sell the crops and purchase manure than to feed the crops to beef in a fattening enterprise. At small herd sizes (100 head) the reduction in income caused by the feeding operation was moderate ($1,300), but with a larger operation (213 head) the income sacrifice increased tenfold.*

Several studies (summarized by Hodges, 1978; Vogtmann, 1984) indicate that farms using alternative technologies, such as those called organic, regenerative, or sustainable, can be as profitable as conventional farms under certain circumstances. However, very few U.S. farms use methods that would be characterized as "organic" according to a widely used definition (USDA, 1980: 9). One reason more farmers have not adopted organic methods is their expectation that yields and profits would be substantially reduced, at least during the transition phase, and perhaps permanently. In practice, some organic farmers have found that their yields have declined, but their costs have also decreased, leaving profits unchanged or sometimes increased. In other circumstances, reduced yield leads to an even greater proportional drop in income.

Nevertheless, anecdotal "success stories" do not constitute a solid base on which farmers could plan the future of their operations. Studies comparing actual operating organic farms with conventional farms have been criticized as lacking adequate statistical controls so that differences could not be attributed solely to organic farming methods. There is very little carefully measured data on the costs, yields, and overall performance of organic farms. The present study uses an unusually complete body of data collected by the Rodale Research Center near Kutztown, Penn., on an adjacent farm that has been operated for several years with methods that are generally considered "organic." It illustrates how such data may be analyzed by use of a multi-year simulation model to estimate the trend in income as a farm enters a transition from chemical-intensive to organic methods.

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Definition and description of the transition process

A farm's profits during the transition from chemical-intensive to organic farming methods are determined by a combination of five kinds of effects: rotation adjustment, biological transition, price, learning, and a perennial effect.

The rotation adjustment effect

The rotation adjustment effect is the reduction in income caused by selection of crops necessary to establish an organic farm plan. Crop rotations are essential to organic farming. The reproduction cycles of various insects, disease organisms, weeds, and other pests are interrupted when different crops are grown in a particular sequence. In instances where the conventional crop mix was rather intensive and the transition involves introduction of less profitable crops such as a sod crop or small grain in place of continuous corn, for example, the financial losses in the early years of the transition can be severe. In other situations, such as starting from a conventional farming scenario featuring a diverse rotation including legumes, the rotation adjustment effect on profits may be minimal or non-existent.

The biological transition effect

The biological transition effect refers to natural processes that tend to reduce profits by reducing yields or increasing costs as a result of shifting from dependence on chemicals to organic methods. For instance, the USDA report (1980: 16) notes:

"Farmers who had previously farmed conventionally reported that crop yields were often markedly reduced during the first several years following the shift from chemical to organic farming. During this transition, severe weed infestations often occurred and crops were sometimes difficult to establish. Occasionally the crops showed symptoms of nutrient deficiency. Farmers said that after the third or fourth year, as the crop rotations became established, yields began to increase and eventually equalled the yields they had obtained chemically."

Severity of the biological transition effect varies according to climatic and soil properties, cropping history, combinations of chemicals used, and transition strategy employed. For example, adoption of organic methods may require additional costs for practices such as cultivation to control weeds. Establishment of populations of biological pest control organisms may take several growing seasons, especially following a long history of chemical applications that has eliminated many of the natural predators (such as specific kinds of insects, mites, nematodes, or bacteria) and other beneficial forms of life such as earthworms and birds. Positive biological impacts on profits may occur as a result of practices such as the substitution of leguminous nitrogen for purchased fertilizers and reliance on biological controls in place of chemical pesticides. These positive biological effects usually do not occur until after a transition period. The length of the biological transition phase varies depending on field conditions, often ranging from three to six years (Koepf et al., 1976; USDA, 1980). Negative biological effects on profits can be minimized through a gradual transition featuring phased reductions in chemical use combined with introduction of beneficial predators and removal of conditions and substances harmful to these organisms. Many authors (Madden, 1984; Oelhaf, 1978; Thimm, 1984; Zerger, 1984) advocate a gradual change-over from chemical-intensive to organic methods. Preuschen (1985) proposes that one-third of the farm be changed over at one time. Some farmers experience no adverse biological effects during the transition; yields may remain high (and in rare instances actually increase) and costs may not increase (in some instances actually decrease) with the adoption of organic methods.

The price effect

During the transition, the farm's profits may be affected by changes in the prices of its commodities. The price effect may be positive, as in situations where "organic" produce commands a premium price. Or the effect may be negative as in situations where insect damage reduces the grade of fresh fruits or vegetables. In other instances, the price effect may be nonexistent—when commodities are sold in conventional markets at regular prices.

The learning effect

The learning effect is the reduction in income related to the farmer's lack of experience or information regarding organic methods. Where the organic technology is complex and risky and the farmer is inexperienced, the learning impact on profits can be formidable. But where the organic technology is relatively easy to adopt, the learning effect may be small or negligible.

Several European authors have addressed the question of how to plan a transition (Aubert, 1981; Grosch, 1985; Koepf et al., 1976; Preuschen, 1985). They all stress the importance of improving the condition of the soil, with crop rotation and manure treatment seen as keys to achieving that goal.

Koepf et al. (1976; 195) suggest that the planning process for a transition should begin with a thorough inventory of "everything on the farm including all the given conditions for production namely:

1. the given natural conditions
2. the interest and particular skills the farmer
3. marketing facilities
4. economic aims, i.e., the necessa net income and also the improvement the farm and its lasting productivity.

Several theses from Gesamthoch chule Kassel, Federal Republic of Ge many, have developed plans for transition on specific existing Germa farms (Grimm, 1984; Kulow, 198 Scharf, 1981/1982; Zerger, 1984 Clearly the process of planning a tra sition is extremely complex, involving learning process for the farmer wh often has to deal with unfamiliar pr duction techniques and to adapt the to his or her specific circumstances. A vice of experts can be invaluable duri the transition. Aubert (1981), Gros (1985), and Preuschen (1985) agree th the help of other organic farmers and a informed extension service (where avai able) can be very valuable. Lack of tec nical information and advice regardi organic methods can be a major barri to adoption of organic systems by si nificantly increasing the farmer's appr hension and uncertainty regarding th financial outcome of the transition.

The perennial effect

Transcending the effects of rotatio adjustment, biological transition, pric and learning is a long-term or perenni effect. That is, after the biological an managerial difficulties are overcome an the rotation is established, and apa from the effects of differential prices f organic commodities, there may be long term effect on the profit of the farm An important element of the perenni effect is the change in profits caused b changing the mix of crops grown an livestock enterprises produced on an e tablished organic farm as compared wi conventional farm management. Th perennial effect may be either positi or negative, depending on whether o ganic farming is inherently advant geous or not from the standpoint of yea to-year profitability of the farm.

The present study emphasizes the r

tational effect of the transition. The biological effect is treated by formulating two alternative scenarios regarding yield changes during the transition; input costs during the transition are assumed to be the same as in established organic farming, and conventional market prices for farm commodities are used in computing net returns. Differences in the management level are eliminated by using production data intended to reflect equally competent and knowledgeable management in both the organic and conventional options. The perennial effect is illustrated.

The Kutztown farm

The farm modeled in this study is a mixed crop and livestock farm located near Kutztown in Berks County, Penn. The 117-hectare farm mainly produces feed for a beef finishing operation. The beef feeder stock are purchased and the finished cattle are sold in conventional markets. The farmer uses crop production methods compatible with the USDA definition of organic farming (USDA, 1980: 9), but the beef feeding operation is managed more conventionally. This study deals only with the crop enterprises. The Rodale Research Center's study of this farm from 1978-1982 (Culik et al., 1983) provided most of our data.

Most of the farm's land (88 out of 117 hectares) is rented from the Rodale Research Center. By rental agreement the farmer is not allowed to use chemical pesticides or herbicides on this part of the land. Except for a small amount of starter fertilizer on corn, all the nutrients are supplied by manure application and a rotation that includes legumes. Weeds on the Rodale land are controlled by means of mechanical cultivation and rotation. On the farmer's other 29 hectares of land, reduced rates of herbicides are used for weed control in corn and soybeans. Strip-cropping is used for erosion control. Tillage is with moldboard plow.

Crop rotation is the major way of maintaining productivity; the crop mix consists of about one-third row crops (corn or soybeans), one-third small grains (wheat, barley, oats and rye), and one-third hay (alfalfa or timothy/red clover). The yields of most crops are somewhat higher than state and county averages (Culik et al., 1983: 36-41).

Livestock on the farm are primarily beef that are purchased at approximately 300 kilograms and fed for 200 to 240 days. The average herd size between 1978 and 1982 was 213 head. A few chickens and hogs are also produced on the farm, in part for home consumption.

To represent variations in land productivity found on the farm, the land was divided into three categories: Land-1 (35 hectares), Land-2 (29 hectares), and Land-3 (53 hectares). Land-1 is the most productive land, Land-3 has the steepest slope and is the least productive. Different yield coefficients were assigned to different land classes, based on crop history and yield data collected by the Rodale Research Center.

The simulation models

Key assumptions

Two assumptions were made in this study regarding the biological transition effect. One was no reduction in yield and the other was a 30% reduction in the first year of transition followed by a linear recovery trajectory in three years. It might be argued that if the farm is operated by a very skillfull manager, the yields under conventional management would be higher than the organic yields. The fact that the Kutztown farm's yields exceed county and state averages suggest that the converse argument could also be made. However, since there is no objective way to compare the farm's soil productivity with that of the county average or to select comparable yields for the different management systems on this farm, the present study initially assumed equal yields, except for hay crops. Organic alfalfa is assumed to be established with a nurse crop (a small grain), with no hay cut in the established year. After the establishment year, organic alfalfa is assumed to yield 7.5 metric tons of hay per hectare for three years of full stand. Conventional alfalfa is assumed to be established without a nurse crop, yielding 3.75 metric tons of hay per hectare in the establishment year. It is then assumed to stand for two years, yielding 7.5 metric tons per hectare per year. A similar reasoning applies for timothy/clover .

Because the goal in this study was to maximize the farm's income during the transition, the financial impact of keeping different herd sizes (including no beef at all) was investigated. It was decided that the size of the beef fattening enterprise in the transition models would be set at the most profitable level, even if that meant eliminating beef entirely. To some observers, elimination of the beef enterprise from the farm plan may seem antithetical to the concept of organic farming. However, the purpose of this study was to determine the most profitable way this specific farm could be organized during a transition from conventional to organic methods. Many organic farms have no livestock, relying totally on legumes and purchased manure as their sources of nitrogen. Clearly this procedure is not incompatible with the USDA definition of organic farming. It would be unrealistic, therefore, to require the farm plan to include a beef enterprise as a source of manure at the expense of a large reduction in profit as compared with a farm plan in which the manure is purchased and the crops are sold rather than fed to an on-farm beef enterprise.

It was assumed that all crops and beef were sold into conventional markets and that chicken manure could be purchased to provide nutrients in the organic options if necessary. The enterprise budgets used in this study are based on Culik et al. (1983): 70 ff.) and on Domanico (1985).

Baseline model of farm under conventional management (CONB)

The baseline condition of the farm was simulated assuming conventional farming methods, a model called CONB. This model permits, but does not require, that beef cattle be raised on the farm. Of course many conventional

farmers produce legumes, raise livestock, and apply manure to their fields. For the purpose of the present study, the conventional version is not required to do so; rather the most profitable enterprise combination is chosen so the results of the conventional and organic options would reflect comparable management skills and efficiency in operation. The constraints on the conventional crop rotations are minimal. Continuous corn is allowed on Land-1 and Land-2; continuous alfalfa is not permitted because in this location pest problems reduce yields after three years. Half of the more erodible Land-3 must be in an erosion-controlling hay crop. No soybeans are allowed on Land-3 because of the high erosion associated with this crop in steep fields.

The CONB model was constructed to answer two questions: (1) Would a profit-maximizing plan using conventional technology include any perennial crop stands (i.e. legumes) that would carry over into the first and second year of a transition? (2) Will there be a nitrogen carry-over from legume crops into the transitional period?

Construction of the transition models, TRANS and TRANS-L

The transition models include a simplified connection between the years to represent the effects of legumes. Legumes not only contribute nitrogen; they also contribute to the positive effect by improving soil tilth, suppressing weeds, and interrupting the reproductive cycles of various pests and disease organisms (Kilkenny, 1984). The nitrogen carry-over from legumes is often thought to be more important than the rotation effect. In the transition models, the nitrogen produced by legumes in one year is transferred as an input into the next year to fulfill nitrogen requirements of non-legume crops. Both the amount of nitrogen transferred and the amount needed were based on figures in the Penn State Agronomy Guide 1985-86, which is based on extensive experimental plot research in various locations around the state.

The other source of nitrogen on the farm is manure that can be bought or produced by on-farm livestock. In analyzing scenarios in which beef cattle are eliminated from the farm, the simulation model purchases manure as required for the farm. The nitrogen requirement constraints were introduced for every year and for every land class.

The transition models include similar requirements for potassium and phosphorus. The nutrient requirements differ for the different land classes according to the yield. The macro-nutrients (N, P, and K) can be obtained from four sources: (1) carry-over from legumes (N only); (2) purchased chicken manure; (3) manure from the cattle on the farm (which supplied N, P, and K in a different proportion and quantity compared to chicken manure); and (4) commercial fertilizer for P and K. Organic farmers prefer commercial forms of P and K that are not highly soluble (e.g., rock phosphates). Because of lack of data on the prices of such fertilizers, the same prices per pound of P and K as used by Domanico (1985) for commercial potassium and phosphorus fertilizers were assumed.

As a preliminary step in the analysis, an extreme approach to the transition was taken in an exploratory model (EXPL). It assumed that the change-over occurred throughout the whole farm in one year. As was pointed out in the literature review, this is not recommended. However, the results of the EXPL model magnified the problems and thus facilitated the construction of the transitional models; the results of EXPL were modified to form a more cautious (and realistic) gradual transition.

Two versions of the model were then developed: The first one (TRANS) incorporates an optimistic assumption that the crop yields during the transition are the same as in conventional and established organic farming. To account for the decreased yields reported by many farmers during the transition, a second version of the model was constructed (TRANS-L). TRANS-L differs from TRANS in several ways. The yields of all crops grown in the first three years are multiplied by yield adjustment factors. For all the other years the yields of TRANS and TRANS-L are equal. For year one, the assumed yield adjus ment factor is 0.7, for year two it is 0. and for year three it is 0.9. These facto are derived from Grosch's (1985) stat ment that in an unfortunate situation t yields during the transition could dr to 70% of the conventional yield. T linear recovery was assumed by Oelh (1978).

Some evidence (including soybe yields of the Rodale Research Cent Conversion Experiment [Dabbe 1986]) suggests legume yields may n decline as much as non-legume yield In fact, alfalfa and soybean yields ma not decline at all. The authors consi ered using yield data from the Roda Conversion Experiment (Culik et a 1983) as the basis for yield reducti assumptions. This approach was not fo lowed because of the high variability the yields and the limitations in the e perimental design (Dabbert, 1986: 1 22). Rather, in the interest of providi a clear lower limit comparison, t TRANS-L simulation model assum that these yield adjustment factors a the same for all crops, including le umes.

Since the amount of nitrogen fixati occurring in a legume crop is general thought to be proportional to the bi mass of the crop, the nitrogen furnish by a legume with decreased yield (i. in the first three years of TRANS-L) w also multiplied by the appropriate yie adjustment factor. The nitrogen needs all crops were conservatively assumed be the same for all the years in t TRANS-L and TRANS models.

To find the optimum (most profitab crop rotations for the farm under esta lished organic management for ea land class, several preliminary versio of TRANS and TRANS-L were r without any requiring any organic cr rotations. Thus the most profitable cr on every land class was found. T shadow-prices (profit foregone) due omitting crops from the simulation s lution revealed the approximate order profitability of these omitted crops. Wi this knowledge, the requirements of t organic systems were introduced. Se eral feasible organic crop rotations we formulated for each land class. The were then compared through the mo

el's profit maximization process (linear programming) to determine the most profitable crop rotation consistent with the organic farming definition. These rotations were then entered into the transition models TRANS and TRANS-L starting from year four, the beginning of the established organic crop rotation in the model. The profits of the organic systems continue to be reduced in years four and five, because the nitrogen cycle using the legumes is only fully established in year six and subsequent years.

For the first three years of the model TRANS, the crop mix on the three different land classes was selected using good agronomic practices, while at the same time profit was maximized. For instance the proportion of organic corn following conventional corn was kept as low as possible to reduce pest problems.

The average cost of buying chicken manure during the study period was estimated to be $12.86 per metric ton, based on the price paid by the Kutztown farm operator, including the cost of hauling and spreading the manure. This study disregards any effects of manure other than the macro nutrients supplied, such as increase in organic matter, micro-nutrients provided, improvement of soil structure, weed seeds introduced, or salinity. Also the effect of a slow decay of manure that contributes nitrogen in the second and subsequent years after the application was not taken into account. These omissions may understate the profitability of organic systems.

Eight years of the model are presented. This includes the three-year transition period, two intermediate years while the nitrogen cycle and income are stabilizing, and a three-year period of stabilized income. Subsequent years of the model would be identical to these last three years in all respects.

Results

Conventional baseline model (CONB)

The model CONB results in an income of $61,900 (Table 1), with "income" in this study representing returns over cash operating costs and not the income of the farm families. To reduce this to net farm income, the depreciation costs, net reductions in inventory, and overhead costs such as interest, taxes, insurance and rent must be subtracted. Family income includes net farm income plus off-farm income of various family members.

In the CONB model results, all of Land-1 and Land-2 is used for continuous corn, the most profitable crop in these land classes. On Land-3 corn is grown up to the upper limit (50% or 26.5 hectares); the other half is in alfalfa. A third of the total baseline alfalfa acreage (8.8 hectares) is in the first year of the stand on Land-3; another third is in the second year of the stand, and the remainder is in the third year of the full stand. These legume stands were carried into the first year of both of the transitional models. That means there was a nitrogen carry-over from the alfalfa grown in the baseline model CONB to the transition models only on Land-3, but none for Land-1 or Land-2.

Transitional model with no yield reduction (TRANS)

In the transitional model TRANS, the most profitable organic crop rotation on Land-1 was found to be a wheat-soybeans-corn rotation (WHT-SB-C). On Land-2 and Land-3 the most profitable organic rotation was WHT-A-A-A-C-C, or wheat followed by three years of alfalfa and two years of corn. The resulting income is reported in Table 1.

On Land-1 the optimum organic rotation (WHT-SB-C) for year one of the transition continues to be the optimal solution for subsequent years. One third of the land class (7.7 hectares) is grown in each crop. Since it is more profitable to buy nitrogen as chicken manure than to produce alfalfa on Land-1, the need for manure on Land-1 is 6.9 metric tons of chicken manure per hectare in the first year, and 5.6 metric tons per hectare in subsequent years (Table 2). On Land-2 the first six years show a general downward trend in the manure required, from 6.9 metric tons per hectare to 2.3 metric tons per hectare (Table 2). The only irregularity in this trend is year two, in which only 2.5 metric tons per hectare are bought. This is a result of the high proportion of soybeans in the first year of transition crop mix. The need for chicken manure for the whole farm drops by approximately a third from year one (531 metric tons) to the established organic situation in year six (348 metric tons). The total expenditure for nutrients drops by approximately 15% from the first year ($10,917) to the established organic expenditure ($9,309). Alfalfa has to be established in a small grain on Land-2; wheat is the most profitable small grain nurse crop. A third of the total area to be allocated to alfalfa on Land-2 is to be established in year one, another third in year two, and the remainder in year three. In the establishment year there is a wheat crop but no alfalfa harvest. By year four the total alfalfa area reaches its maximum for Land-2 of 14.5 hectares. This is 50% of Land-2, the amount of alfalfa deter-

Table 1. Income of TRANS and TRANS-L Losses Compared to Established Organic, and Losses Due to Rotational and Biological Transition Effects, by Year.

Year	Income of TRANS	Income of TRANS-L	Losses Due to: Rotation Adjustment Effect	Losses Due to: Biological Transition Effect
0(CONB)	$61,900	$61,900	—	—
1	54,000	35,000	$3,400	$19,000
2	56,700	44,100	700	12,600
3	57,600	48,700	−200	8,900
4	56,400	56,200	1,000	200
5	57,400	57,300	0	100
6	57,400	57,400	0	0
7	57,400	57,400	0	0
8	57,400	57,400	0	0

Table 2. Chicken Manure Bought for TRANS by Land Class and Year (metric tons)

Year	Land-1		Land-2		Land-3		Whole Farm	
	Total Amount	Per Hectare	Total Amount	Per Hectare	Total Amount	Per Hectare	Total Amount	Cost
1	244	6.9	203	6.9	84	1.6	532	$6840
2	197	5.6	72	2.5	84	1.6	353	4540
3	198	5.6	141	4.8	84	1.6	422	5430
4	197	5.6	91	3.1	84	1.6	372	4790
5	197	5.6	72	2.5	84	1.6	353	4540
6	197	5.6	67	2.3	84	1.6	348	4480
7	197	5.6	67	2.3	84	1.6	348	4480
8	197	5.6	67	2.3	84	1.6	348	4480

mined in the optimum crop mix of the organic rotation (Figure 1).

On Land-3, the most profitable rotation throughout the transition turned out to be WHT-A-A-A-C-C. The average need for chicken manure on Land-3 is 1.6 metric tons per hectare in every year. In actual practice, the farmer would apply a larger amount in fewer years, preferably on the wheat and corn.

Transitional model with reduced yields (TRANS-L)

For TRANS-L (the model version with reduced yields and a linear recovery during the transition in years 1 to 3) the same crop mix was found to be the optimum as in TRANS. However, there are large income differences between the two models in the first three years (Table 1). Reduced yields cause a greater proportionate reduction in income.

TRANS-L also differs from TRANS in some of its manure needs. In TRANS-L, less nitrogen was furnished by legumes because the yields of biomass are lower. However, the requirements of the other crops were conservatively assumed to be the same as in TRANS in spite of the decreased yields during the transition years. This results in a slightly higher amount of manure purchased in year two through five for TRANS-L as compared to TRANS.

As increasing herd sizes are incorporated into the TRANS model, income declines. Expanding herd size up to 100 head reduces income by only $1,300, whereas a 213 head beef enterprise reduces income by $13,100 as compared with selling all the crops and buying manure.

A yield loss of 30%, as assumed in the first year of TRANS-L, has a serious financial impact. The trend in income from TRANS-L shows how income is reduced by the combination of the rotation adjustment effect and the biological transition effect, while TRANS (assuming no yield decline) shows only the reductions from the rotation adjustment effect. Because the two models r
resent the same crop rotations,
biological effect (Table 2, column 5
estimated by subtracting the income
TRANS-L from the income of TRA
in respective years. The biological tr
sition effect declined from $19,000
year 1 to zero in year 6. The "rotati
adjustment effect" in a given year is
timated by subtracting that year's
come of the TRANS model from
income of the TRANS model in year
(column 4). This effect declined fr
$3,400 in year 1 to zero in year 5.

The "perennial effect" is calculated
the income from one of the transitio
models after the organic rotation
been established, such as in year 6,
nus the income from the conventio
model (Table 1, year zero). Given
assumptions and resource endowme
used in this study, the perennial eff
is estimated as minus $4,500, or a 7.
reduction in income as compared w
conventional operation.

Figure 1. Allocation of Crops Among Six Equal Size Segments on Land-2 and Resulting Crop Rotations

Field No.[1]	Conventional Operation, Year	Adjustment Phase, year		Intermediate Phase, year			Established Phase, year		
	0	1	2	3	4	5	6	7	8
1	CG[2]	CG	WHT	ALF1	ALF2	ALF3	CG	CG	WHT
2	CG	SB	CG	WHT	ALF1	ALF2	ALF3	CG	CG
3	CG	WHT	SB	CG	WHT	ALF1	ALF2	ALF3	CG
4	CG	WHT	SB	CG	CG	WHT	ALF1	ALF2	ALF3
5	CG	WHT	SB	CG	SB	CG	WHT	ALF1	ALF2
6	CG	WHT	ALF1	ALF2	ALF3	CG	CG	WHT	ALF1

[1] Each "field" is about 5 hectares.
[2] CG = Corn Grain
SB = Soybeans
WHT = Wheat, Nurse Crop for Alfalfa
ALF1 = Alfalfa in the First Year of the Full Stand
ALF2 = Alfalfa in the Second Year of the Full Stand
ALF3 = Alfalfa in the Third Year of the Full Stand

Discussion and conclusions

Modeling the transition process

We have demonstrated the use of a multi-year simulation model to predict the income effect of a transition from conventional to organic farming. This analytical method has several advantages, particularly in its capacity to eliminate the confounding effects of differences in management ability.

The empirical findings of this study illustrate the common knowledge that a transition to organic farming can cause severe short-term financial losses for a farm, but the magnitude of these losses (as compared to established organic farming or a continued conventional operation) can vary widely under different yield reduction scenarios (Figure 2). Losses due to the rotation-adjustment effect are most severe in a phase of reorganization before the crop rotations become fully established. During a transition which involves a shift to a less profitable rotation, these losses are unavoidable. The established organic rotation is reached on all land classes in year four, but the rotational effect on income is not completely overcome until year six of the models, when the legumes begin providing their maximum contribution to the farm's nitrogen supply. In year four and year five the nitrogen supply from the legumes is not yet fully established.

Soil erosion is not limited in this study; the conventional option earns a 7.3% higher profit, while incurring nearly twice as much soil erosion as the established organic farming option. Domanico et al. (1986) have shown that if the soil erosion on this farm was limited to an average of 5 tons per acre or less, organic farming methods would produce a higher income than conventional farming. For example, when soil erosion is limited to 3 tons per acre, the organic option earns 11% higher income than conventional. An even greater income differential occurs when overseeding of legumes into corn is included as a management strategy.

The price effect and learning effect are not applicable in this study, because it was assumed that all products were sold into conventional markets with no price differential for organic production, and that the farmer was fully capable of implementing organic methods.

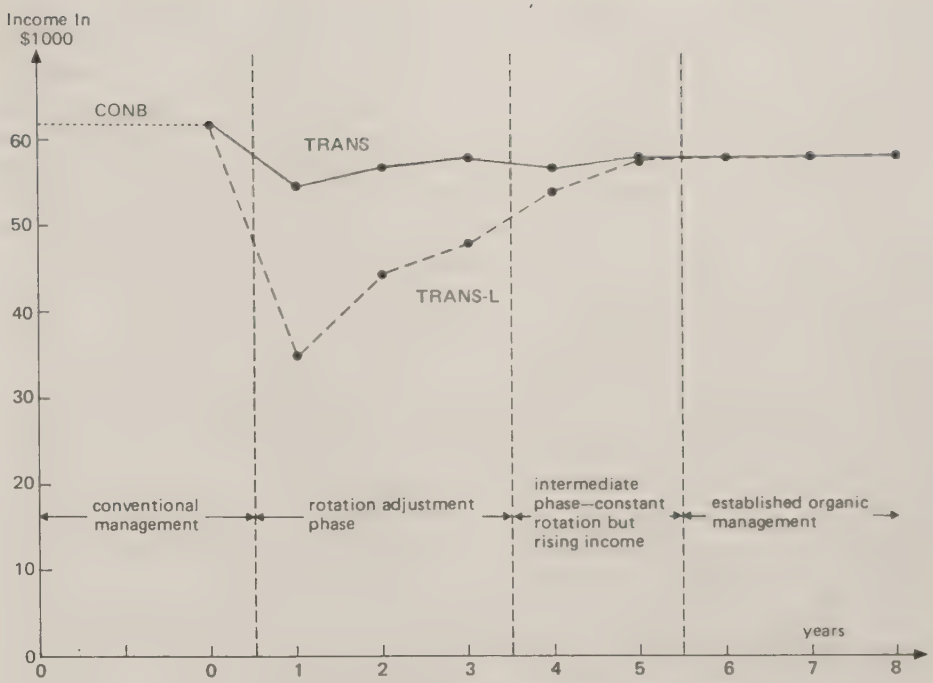

Figure 2: Income of TRANS, TRANS-L, and CONB.

It is clear that yield loss is a major factor that influences the financial viability of a farm during the transition. Unfortunately there are no clear-cut rules for maintaining a profitable yield level. Certainly, nutrient supply is a factor; for that reason the models required an adequate supply of nitrogen, phosphorus, and potassium. Organic farmers cope with severe weed problems by additional mechanical cultivations and a diverse crop rotation. The crop rotation is also the key to avoiding pest and disease problems. If major pest or disease problems did occur during the transition phase, a practical organic farmer would probably use some chemicals—preferably the minimum effective dose of the least harmful pesticide. This emergency measure is compatible with the USDA definition of organic farming. There is some evidence (Dabbert, 1986; Grosch, 1985) that the yield reduction factors are different for different crops. Since no exact data exist for Pennsylvania, a conservative approach was taken: equal yield reduction factors for all crops have been assumed. If yields for legumes did not decline as much as those for other crops, legumes would become relatively more profitable, and would therefore tend to take the place of non-legumes in the rotations. Manure purchases would be reduced and incomes would increase as compared with those reported from TRANS-L.

CONB represents an extreme approach to conventional farming. This approach results in continuous corn on two land classes and is associated with high erosion (compare Domanico, 1985). However, it illustrates a radical change in the crop mix during the transition. This extreme approach is in large part responsible for the sharp decline in income during the transition. On Land-2 the proportion of land allocated to corn was limited so as to minimize the amount of organic corn following conventional corn in the first year of the transition models. Having organic corn following conventional corn could lead to severe yield losses resulting from pest infestations, since pesticides are not used in the organic corn (except in emergencies) and the natural predators and rotational effects would not reach their full potential until after more years of or-

Table 3. Income Assuming Various Herd Size for TRANS Model

Herd Size	Income
213	$44,300
200	47,300
150	53,900
100	56,100
50	57,000
0	57,400

ganic farming.

On Land-2 and Land-3 alfalfa cannot be established during the baseline year because of lack of a nurse crop. This delays the first harvest of a profitable alfalfa hay crop by a year. These findings illustrate Grosch's (1985) point that a transition becomes more difficult the more chemically intensive the conventional operation is. Grosch referred primarily to the biological transition effect, but his statement is also true for the rotation adjustment effect of the transition. This means it might be a successful strategy to gain a gradual transition by reducing the intensity of the conventional crop rotation before adopting the full transitional rotation. This would reduce the financial losses during the transition, but it might also lower the profit during the end of the conventional management state.

The different amounts of manure needed on the different land classes in the established organic situation (see Table 2) reflect the different proportion of legumes (especially alfalfa) in the crop mix. The absence of alfalfa in the profit-maximizing rotation on Land-1 means that on good quality land, under the assumed prices and yields, it is more profitable to have a crop rotation that relies entirely on soybeans and the import of manure for nitrogen rather than to commit the land to three years of alfalfa.

Three conclusions emerge from the findings: (1) Even if there is a high proportion of alfalfa in the crop rotation, manure is still needed during the transition period to bridge the gap until the alfalfa is fully established. (2) If a crop rotation does not include a perennial legume, the need for imported nitrogen remains basically constant over the years, and (3) It is necessary to spend more on nutrients during the transition period than in the established organic farming situation.

The results of TRANS when beef is introduced into the programming model indicate that the beef feeding enterprise was not the most profitable use of resources under the circumstances of the Kutztown farm. For small sizes of beef herd, the decrease in income is moderate. If the farmer fattens 100 head of beef, the income in the established organic situation is only $1,300 lower than without beef (Table 3), whereas with 213 head, the sacrifice in income is ten times greater. Sensitivity analysis showed that the beef enterprise remains unprofitable even with substantially higher beef prices. The manure produced by the cattle as an input to the organic system is included as a positive contribution in this calculation. As with the crop enterprises, income from the beef feeding operation is calculated as the net return over cash operating cost.

Limitations of the study

As a hypothetical case study based on an actual Pennsylvania farm, this study illustrates by mathematical programming simulation how a transition from chemical-intensive to organic farming could have occurred. The hypothetical character of the study implies both strengths and weaknesses. The models are based largely but not entirely on empirical data. In the construction of the transitional models, the possibility of a decline in yields was taken into account. Both a positive and a negative borderline case were modelled. An actual transition would probably be somewhere between those extremes. Also, it is possible, though not very likely in most crops and locations, that yields might increase during and after the transition, as compared with conventional farming. If so, the income comparisons would be different, depending on variations in production costs and returns.

The study incorporates only a limited part of organic methods. It was based on data collected on a single farm. Other farms might use different enterprises successfully or might use a different production technology for similar enterprises, thus obtaining different costs, yields, and incomes.

If many farms were to attempt transition from chemical-intensive to ganic methods of production, the pri of farm commodities such as beef, co and wheat, as well as the cost of inp such as manure, would be likely change. For example, shortages of n nure could drive up its price; reducti in crop yields could cause commod prices to rise; the most profitable ro tions would change as prices of co modities and inputs changed; regio and international patterns of producti could be altered; the profitability of ganic and conventional farming could modified, and the pattern of farm s could be affected. All these possibilit lie beyond the scope of this study.

Ordinarily, multi-year econon models include a procedure for co puting the discounted present value several years of income, using an sumed discount rate. Because the p cedure used in this study gives hi priority to attainment of a meaning and stable organic rotation, introducti of a discount rate would not change optimal solution. It would just discou the incomes, without having any inf ence on any of the cropping activiti For purposes of the present study, discounted income is maximized. The fore the income stream over transitional period is not adjusted loss of value due to inflation or for p sible interest earnings on income. Th is, income earned during early years the transition is not valued higher th income in subsequent years.

This study was not designed to dec whether organic or conventional te nology is more profitable. The follow limitations are relevant to such a co parison:

(1) Comparisons of conventio management, the transition phase established organic management meaningful only if the management els are comparable. For this reason t study used linear programming to f the most profitable combination of cr for each scenario being modeled. T approach involves approximation judgment. For instance, yields and source requirements for organic crop

tations during a transition phase can only be estimated because experience is limited.

(2) The assumption about equal yields in a conventional and the established organic system (in TRANS) can be criticized. As a whole the literature reports slightly lower yields on organic farms than on conventional farms (Diercks, 1983; Grosch, 1985; Vogtmann, 1984). However, in the case of corn, which plays a major role in the crop rotations on this farm, Lazarus et al. (1980) report significantly higher yields for rotational corn than for continuous corn. This is true regardless of the type of rotation and can be considered a positive rotation effect. In this study, the conventional corn is continuous and the organic corn is in a rotation. This would tend to favor the organic yields. It is possible, of course, for conventional farms to grow corn in a rotation and thereby capture the rotation benefit (in higher yields) while still using chemicals and other conventional technology. As a whole it can be said that the assumption of equal yields is a defensible one, but by no means the only one possible.

(3) On the cost side, the amounts of potassium and phosphorus assumed to be required in the transition models are the same standard replacement requirements as applied in the conventional system. These rates are higher than the literature on organic agriculture would suggest. This imposes an artificial disadvantage on the organic system, because higher amounts than usually recommended for this system are required in the present study for the sake of reaching conservative estimates for income and long-term sustainable yields. Organic farmers usually operate on the lower range of nutrient requirements and do not routinely add every year what has been taken away from the soil in crops, erosion, and leaching. In an effort to avoid adding commercial fertilizer, organic farmers try to recycle nutrients as much as possible on the farm (USDA, 1980).

(4) The optimum farm plans developed in this study break the nutrient cycle on the farm because the beef feeding enterprise is not profitable under the prices assumed in this study.

(5) While resource requirements and costs in the transition budgets are assumed to be the same as those in the established organic budgets, yields vary. However, there is a real possibility that a farmer during the transition would incur higher cost because of the need to apply pesticides in an emergency case or to do additional cultivations to fight severe weed pressure. This would further decrease profits during the transition.

(6) The output prices are assumed to be the same in conventional and organic in this study. For certain commodities, a premium price is received if they are marketed as "organically produced." This premium depends on the commodity, location, access to organic markets, and marketing skills of the farmer. If premium prices could be attained, the relative profitability of organic farming would be higher than indicated in this study.

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Comparison of the phosphorus status of soils managed organically and conventionally

Laura L. Lengnick and Larry D. King

Abstract. *Soils from adjoining farms, one managed organically and the other managed conventionally, were used in a greenhouse study to compare soil P status and the efficiency of concentrated superphosphate (CSP) and North Carolina rock phosphate (RP). Soil and plant parameters were measured as indicators of levels of soil P forms and availability of soil P to soybeans (Glycine max L.). Management did not affect dry matter yield of soybean plants. Conventional management resulted in higher P concentration in the plant and higher P uptake when CSP was the P source. However, when RP was the source, management effect was not significant. RP was only 15% as effective as CSP in increasing yield. When no P was applied, organic management resulted in greater total soil P, organic P, and Ca phosphate (CaP); conventional management resulted in greater Al and Fe phosphate (AlFeP) and occluded AlFeP (OcP). Addition of CSP increased AlFeP and OcP. Addition of RP increased CaP. CSP was more effective than RP in increasing extractable soil P. Multiple regression analysis showed that extractable P was related to AlFeP when CSP was the P source and to CaP when RP was the source. Yield was related to extractable P when CSP was the P source but when RP was the source, no significant regression models were found for yield.*

Introduction

The high input, energy-intensive conventional agricultural system in the U.S. is facing a tremendous challenge. Rising input costs have become a major problem for producers. Present farming practices have resulted in topsoil loss and environmental pollution. Most importantly, since conventional systems rely largely on non-renewable energy resources, these systems may be difficult to sustain as such resources are depleted. Thus, sustainable food and fiber production systems must be developed.

A question of sustainability

The ability to produce food and fiber over the long term is essential to the stability of a society but too often agricultural scientists do not consider agricultural practices in the long term. Economic and environmental problems associated with conventional agricultural systems have raised a legitimate question: Is this system sustainable?

Organic management systems address many of the negative aspects of conventional systems (USDA, 1980). For example, they (a) Decrease soil erosion through use of rotations and organic matter management. (b) Decrease dependence on non-renewable inputs through use of nutrient cycling, organic materials and unrefined minerals. (c) Decrease pesticide use through use of integrated pest management techniques and timely management to reduce pests.

Indeed, many organic practices are considered best management practices for "controlling soil erosion, minimizing water pollution and conserving energy" (USDA, 1980). Since many organic practices reduce the impact of agriculture on the environment and reduce the dependence on non-renewable inputs, organic systems may offer a sustainable alternative to conventional systems. However, maintenance of soil fertility is required for an agricultural system to sustainable.

Evidence shows that organic syste are not balancing nutrient inputs wi nutrient exports (Bellon and Trancha 1981; Lockeretz et al., 1980; Patt 1982). While nitrogen (N) needs a being met through the use of legum organic systems appear to be drawi on pre-existing reserves of phosphor (P) and potassium (K) (USDA, 198 Because of the soil-P interactions uniq to this nutrient, P input/export balan in systems utilizing P sources of low s ubility or concentration may be diffic to attain. The ability of organic syste to maintain P and K levels sufficient optimum plant growth needs to be tablished before these systems can considered truly sustainable.

Organic farming in the Southeastern United States

All published research involving ganic farming has been conducted in t cool temperate regions of the U.S. wh climatic influences on soil developme weeds, and insects tend to allow su cessful organic management. Soils a generally fertile, relatively high in ganic matter and highly buffered w respect to P and K. Seasonal tempe ture variations aid in the control of pla pests and diseases. However, in t southeastern U.S. high rainfall and te peratures have resulted in formation less fertile soils that are highly wea ered, low in organic matter (OM) a high in acidity. The relatively mild w ters are less conducive to the control plant pests and diseases. USDA (19 sources indicate that these and other f tors such as market availability limit ganic farming in the South.

In personal communications with

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ganic farming groups and agricultural extension agents in Virginia, North Carolina, and South Carolina while seeking farms for the comparison study reported in this article, many of these constraints to organic farming were mentioned. Farmers indicated that the greatest constraint to organic management was lack of information on appropriate practices. The most commonly mentioned environmental constraint was low soil fertility. These constraints have shaped the organic farms in the Southeast. Most farms are relatively small, have been managed organically for less than five years, and usually produce fruit or vegetables for the fresh market. No commercial scale organically managed cash grain farms were found in North or South Carolina.

Lack of information on management techniques is a severe problem for the organic farmers interviewed. Many of these producers were dissatisfied working with the conventional agricultural establishment. They suggested that extension agents are antagonistic to organic management principles and attempt to discredit them. However, many extension agents maintained they did not recommend organic practices simply because no research is available upon which to base recommendations. Some agents indicated that if appropriate research were available from the conventional agricultural community, they would be willing to make recommendations to organic producers.

The work reported here addresses one of the constraints on organic management in the Southeast--nutrient availability. Soils from adjoining farms, one managed organically and the other managed conventionally, were used in a greenhouse study to compare soil P status and the efficiency of concentrated superphosphate and North Carolina rock phosphate.

Materials and methods

A survey of organic farms in North and South Carolina and Virginia was conducted to find a suitable organic farm and adjacent conventional farm for comparison. Criteria for selection were that the organic farm must have been under organic management for at least five years, both farms must be on the same soil type and both farms must grow row crops on at least 40 ha. The site chosen is located in King George County in northeastern Virginia on the Rapahannock river. The soil is a Wickham sandy loam (fine loamy, mixed thermic Typic Hapludult), thin solum variant, 0- to 2% slope.

The organic farm was farmed conventionally from the early 1900's until organic management was started in 1977. From 1977 to 1980 commercial organic amendments such as Wonder Life and several micronutrient fertilizers were used (Table 1) and comfrey (*Symphytum officinale* L.) was grown in the field from which soil was obtained for this study. The leaves were harvested and sold for making tea and the roots were sold for use in establishing comfrey plantings. In 1981 soybeans (*Glycine max* L. var. Essex) were planted with no fertilizer addition. In 1982 and 1983, after seedbed preparation, 448 kg/ha Fertrell Blue was drilled in 10-cm rows with the soybean seed. Fertrell Blue is a commercially prepared organic fertilizer consisting of organic wastes and ground minerals and contains 100 g/kg total N, 140 g/kg total P and 70 g/kg total K. No cover crop was planted after soybean harvest.

The adjacent farm has been managed conventionally since the early 1900's. Since 1978 the field from which soil was obtained for this study had been in a wheat (*Triticum vulgare* L. var. Tyler) and Essex soybean rotation. The management used since 1978 was 11 kg N/ha, 34 kg P/ha and 67 kg K/ha broadcast as a liquid fertilizer prior to planting wheat in the fall and 90 kg N/ha topdressed in the spring. After wheat harvest, 3.8 L/ha (1.7 kg active ingredient/ha) Lasso (alachlor,2-chloro-2',6'-diethyl-N-(methoxymethyl)-acetanilide) and 1.2 L/ha (0.7 kg/ha active ingredient) Lorox (linuron, 3-(3,4-dichloro-

Table 1. Fertilizer program used on the organic farm prior to the study.

Soil amendments used

Amendment	Description	Total analysis										
		N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	B
		g/kg										
Calcium blend	$CaCO_3$, S, ferrous oxalate manganous and zinc oxides	0	0	0	200	0	200	10	10	20	—	—
Calphos	soft phosphate clay (colloidal phosphate)	0	80	0	150	—	—	—	—	—	—	—
Fertrell Blue plus P	rock powders and N tankage	100	140	70	—	—	—	—	—	—	—	—
Micro-Hume	leonardite shale and iron sulfate	—	—	—	—	—	—	5	—	—	—	—
Nutri-Min-Zinc	S; chelated Mg, Fe, Mn, Zn, Cu; urea, ammonium polyphosphate, potassium nitrate	200	20	70	—	10	15	0.4	0.25	70	0.25	—
Sol-U-Bor	sodium borate	—	—	—	—	—	—	—	—	—	—	210
Wonderlife	lignite coal	20	10	20	10	5	10	1	0.5	0.5	0.2	—

Schedule of applications

Year	Amendment	Rate	Total nutrients applied										
			N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	B
		kg/ha											
1978	Calcium Blend	22	0	0	0	4	0	4	0.2	0.2	0.4	—	—
	Micro Hume	6	—	—	—	—	—	—	tr[+]	—	—	—	—
	Nutri-Min-Zinc	3	0.6	0.1	0.2	—	tr	tr	tr	tr	0.2	tr	—
	Sol-U-Bor	1	—	—	—	—	—	—	—	—	—	—	0.2
	Wonder Life	448	9	4	9	4	2	4	0.4	0.2	0.2	0.2	0.1
1979	Wonder Life	448	9	4	9	4	2	4	0.4	0.2	0.2	0.2	0.1
	Calphos	840	0	67	0	126	—	—	—	—	—	—	—
1980	no amendments												
1981	no amendments												
1982	Fertrell Blue plus P	448	45	63	31	—	—	—	—	—	—	—	—
1983	Fertrell Blue plus P	448	45	63	31	—	—	—	—	—	—	—	—

[+] "tr" indicates less than 0.1 kg/ha

phenyl)-1-methoxy,1-methylurea) were applied to control weeds, and soybeans were planted in 75-cm rows with a no-till planter.

In 1983 a field study was conducted to compare the soil fertility status and soybean yield on the two farms. Results of that study are reported elsewhere (Lengnick, 1985).

Soils for the greenhouse study were taken from fields which have similar slopes and aspects, are approximately 100 m apart,and are separated by a fence row along the property line. Bulk soil samples were collected from the 0- to 10-cm layer in a 10 by 10 m area selected for similar texture in each field. Treatments used in a factorial experiment were soil management (conventional and organic), P fertilizer source (concentrated superphosphate (CSP) and North Carolina rock phosphate (RP)), and P fertilizer rates of 0, 50, 100, 150, 200 kg P/ha (0, 375, 750, 1125, and 1500 mg P/pot). The 50 kg/ha rate was that recommended for the soil from the conventional farm based on Mehlich 3 extractable P. The higher rates were used to assure that P uptake would plateau. Rates were based on the volume of soil in the pots.

Total P content of the two sources was 197 g P/kg for CSP and 135 g P/kg for RP. An additional treatment consisted of Fertrell Blue at 448 kg/ha to simulate the organic farmer's practice of applying Fertrell with the seed at planting. This rate supplied 69 kg total P/ha and 7.6 kg of available P/ha. Treatments were arranged in a randomized complete block design with four replications.

Six Forrest soybean seeds were inoculated with a commercially available inoculum (*Rhizobium japonicum*) and planted in 4-L pots (equivalent of 5 kg oven dry soil/pot). At two weeks, plants were thinned to two per pot. At seven weeks, the soybeans flowered and the most fully developed trifoliate leaves were harvested from each plant. Then the above-ground whole plant and roots were harvested separately and soil samples were taken from each pot. Roots were rinsed in distilled water and stored in a solution of 50 ml formalin, 50 ml acetic acid, and 900 ml ethyl alcohol to preserve the samples until staining for mycorrhizal analysis. Soil samples were air-dried, ground to pass a 2-mm sieve and stored at room temperature. Plants samples were oven-dried for 48 hours at 70°C, ground in a stainless steel Wiley mill and stored in polyethylene bags.

Soils from all treatments were analyzed for Mehlich 3 extractable P (Hatfield and Hickey, 1981). The effective cation exchange capacity (ECEC) was calculated by summing the Mehlich 3 extractable bases. A 1:1 soil/water (volume) ratio was used for pH determination. Aluminum and iron phosphate (AlFeP), calcium phosphate (CaP) a occluded AlFeP (OcP) were determi by the method of Olsen and Somm (1982), with the exception of the anal of the citrate bicarbonate (CB) and trate bicarbonate dithionate (CBD) tracts. These were analyzed for P by method of Weaver (1974). Organic m ter (OM) (Nelson and Sommers, 19 and total P (Sommers and Nelson, 19 also were determined. Organic P (Or was determined by ignition (Nelson Sommers, 1982). Initial soil proper are shown in Table 2.

Table 2. Initial characteristics of the soil used in the greenhouse study.

Soil management	Particle size distribution			pH	Exchangeable cations			Effective CEC*	Extractable P‡	Organic matter	Fert r
	sand	silt	clay		Ca	K	Mg				
	-------g/kg-------				------- cmol(+)/kg--------				mg/kg	g/kg	kg
Conventional	580	280	140	5.7	1.9	0.4	0.3	2.6	20	12	
Organic	710	200	90	5.7	2.0	0.3	0.9	3.2	11	17	

* Effective CEC = Σ exchangeable Ca, K, and Mg
‡ Mehlich 3 extractable

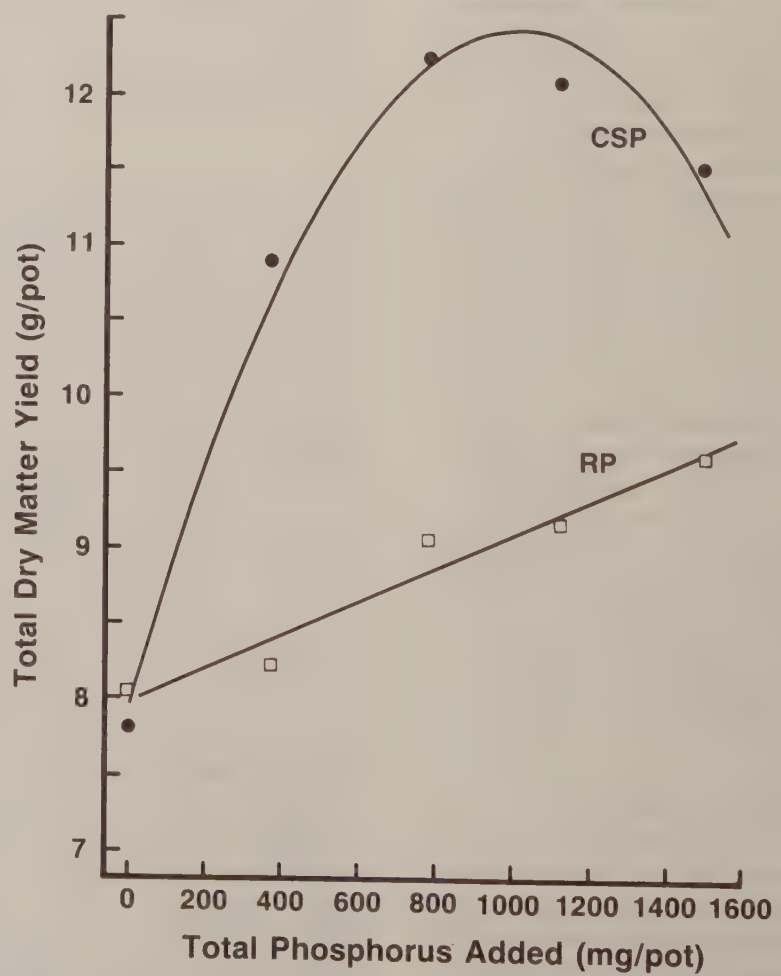

Figure 1. The effect of concentrated superphosphate (CSP) and rock phosphate (RP) addition on yiel of soybeans at flowering, data averaged over management systems.

Table 3. Results of analysis of variance of yield and P data from the greenhouse experiment.

Parameter[+]	Source of variation						
	Management (M)	P Source (S)	P Rate (R)	M × S	M × R	S × R	M × S × R
Yield	ns	***[*]	***	ns	ns	***	ns
P uptake	***	***	***	***	ns	***	ns
Plant P conc.	***	***	***	***	***	***	ns
Leaf P conc.	ns	***	***	ns	***	***	ns
Extractable P	***	***	***	***	***	***	***
Total soil P	***	ns	***	ns	ns	ns	ns
AlFeP	***	***	***	ns	ns	***	ns
CaP	***	***	***	ns	ns	***	ns
OcP	***	***	***	ns	ns	***	ns
OrgP	***	ns	ns	ns	ns	ns	ns

[+] Total dry matter yield (Yield), total P uptake at flowering (P uptake), P concentration in above-ground plant (Plant P conc.), P concentration in the most fully developed trifoliate leaf at flowering (Leaf P conc.), Mehlich III extractable soil P (Extractable P), soil aluminum and iron phosphate (AlFeP), soil calcium phosphate (CaP), soil occluded AlFeP (OcP) and soil organic phosphorus (OrgP).
[*] *** indicates the F test for the source of variation was significant at $P \leq 0.01$.
ns = not significant

Total above-ground plant samples were analyzed for N by the Kjeldahl method (Bremner and Mulvaney, 1982) and for K by dry ashing, taking up in HCl and analyzing by flame photometry (Gilliam et al., 1968). Plant tissue was dry ashed at 550°C, taken up in HCl and analyzed for P colorimetrically (Gilliam et al., 1968). Roots were stained for mycorrhizal analysis and stored in glycerin (Phillips and Hayman, 1970). Extent of mycorrhiza infection was determined using the gridline-intersection count method (Giovannetti and Mosse, 1980).

All treatments were given the same amount of deionized water daily and no pesticides were applied during the course of the experiment. Statistical analysis was performed with SAS statistical packages (SAS, 1982).

Results and discussion

Statistical significance of main effects and interactions for the greenhouse data is shown in Table 3. When interactions are significant, the interaction rather than the main effects will be discussed since this procedure provides a more accurate interpretation of the data.

Soybeans

For most plant parameters, management did not influence plant response significantly and the source x rate interaction was the most common significant effect observed. For example, yield response (total dry weight at flowering) to CSP was much greater than response to RP (Figure 1). Comparison of the linear portion of the CSP response curve with the linear response to RP shows RP was 15% as efficient in increasing yield as was CSP. The rate x source interaction was also significant for P concentration in the whole plant as evidenced by a linear response to CSP but neligible response to RP (Figure 2).

The only plant growth parameters that were affected by management were P concentration and uptake. Management affected P concentration in the above-ground portion of the plant (whole plant) and the P uptake (whole plant concentration x yield) in that the P source x management interaction was significant (Table 3). With CSP, conventional management resulted in higher P concentrations and P uptake but with RP, the effect of management system was not significant (Figure 3).

The rate x management interaction was significant for P concentration in the leaves but it does not appear to be a biologically significant one so the data are not presented. Although the conventionally managed soil had about twice as much extractable P as did the organically managed soil (Table 2), differences in leaf P concentration in the

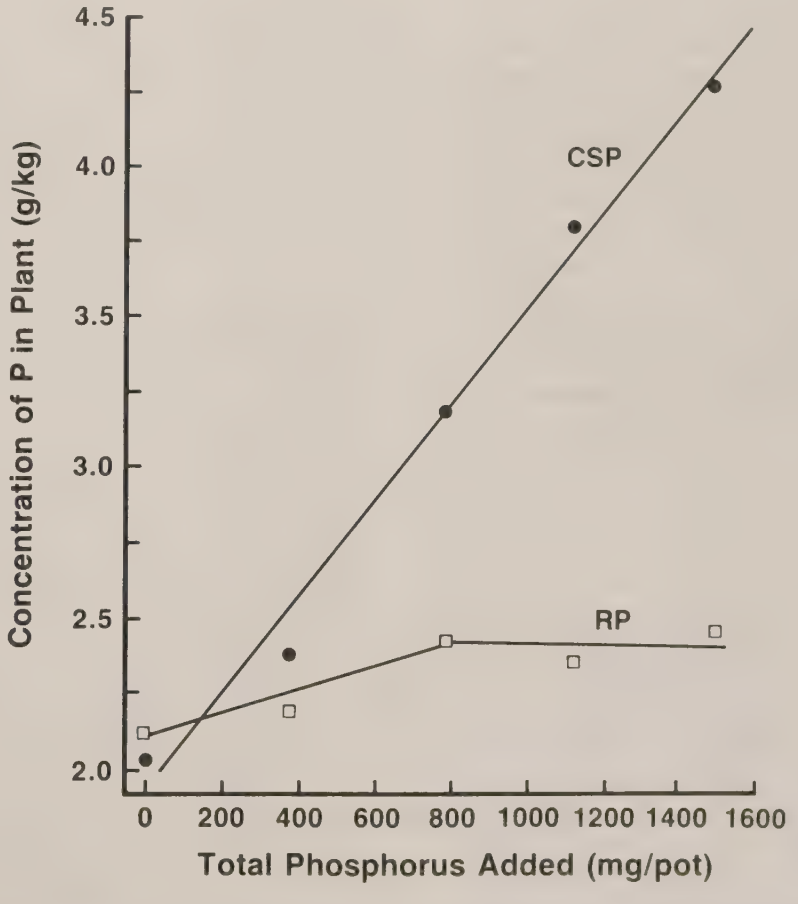

Figure 2. The effect of concentrated superphosphate (CSP) and rock phosphate (RP) addition on the concentration of P in above ground soybean plants at flowering, data averaged over management systems.

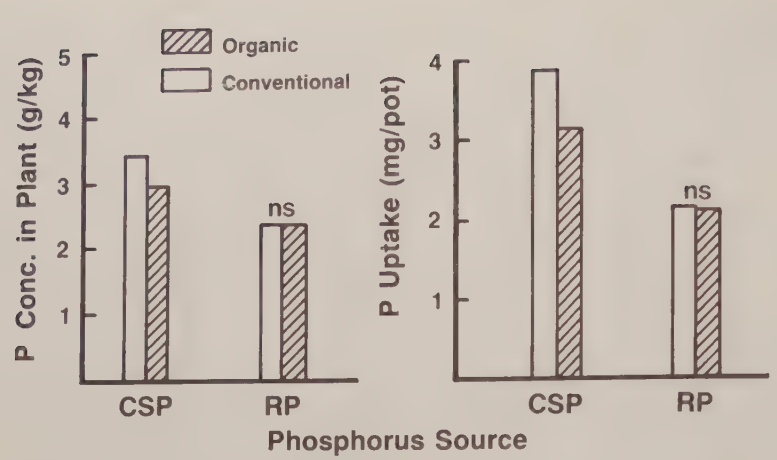

Figure 3. The effect of P source (concentrated superphosphate [CSP] and rock phosphate [RP]) and soil management (conventional and organic), on the concentration of P in the whole plant and the total P uptake by soybeans; data averaged over rates. "ns" indicates that differences were not significantly different at the 1% level of probability.

controls soils were not significant (Figure 2, zero P rate). Evidently some source of P in the organically managed soil is available to plants but is not measured by the Mehlich 3 extractant. One possible source could be P made available by mycorrhizae. Research has shown that in soils with low P concentrations, mycorrhizae can increase nutrient uptake and growth of plants (Tinker, 1980). The P uptake data from the control soil suggest that mycorrhizae may have influenced P uptake in the organic system. The results of analysis of the control soils for mycorrhizal infection indicated a significantly higher percentage of infected roots in plants in the organically managed soil (28%) than in plants in the conventionally managed soil (15%). Treatments receiving CSP and RP were not analyzed for mycorrhizal infection.

Soil

The management x source x rate interaction was significant for extractable soil P (Table 3). With each P source, addition of P fertilizer to the conventionally managed soil resulted in higher extractable P than that in the organically managed soil (Figure 4). The rate effect was similar for management systems with RP but with CSP the rate effect was greater with conventional management than with organic management (i.e. the slope of the lines for conventional and organic were significantly different when CSP was the P source but were not when RP was the source). This management effect on extractable P with CSP is reflected in the greater P concentration in the plants and greate uptake noted previously (Figure 3).

The differences in plant P concen tion and uptake and in extractable P are not a result of a phenome unique to organically managed syste They illustrate the relationship betw the quantity of P satisfying the fixat capacity of the soil and the amount P in solution, i.e., the quantity vs int sity concept (Bache and Williams, 19 Khasawneh, 1971). In the control tre ment the conventionally managed had greater extractable P than did organically managed soil. Thus, as CSP rate increased, the conventiona managed soil approached the fixat capacity for P before the organica managed soil did and consequently greater proportion of the applied P mained available to plants in the c ventional system. The range extractable P produced in the s amended with RP was too narrow allow observation of this effect.

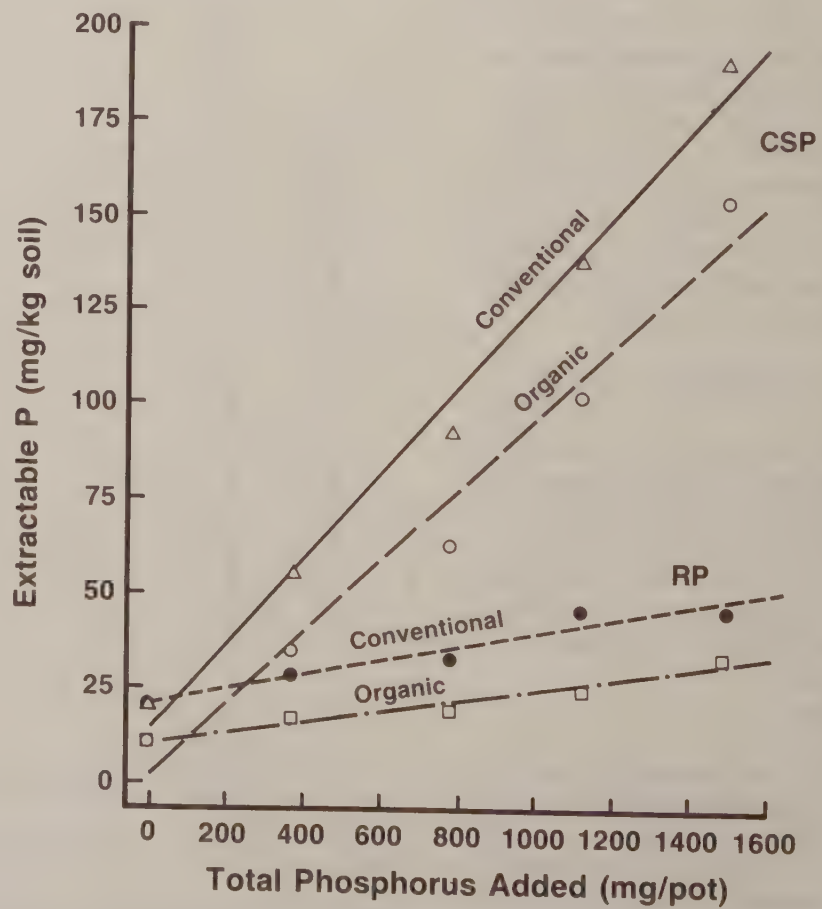

Figure 4. The effect of concentrated superphosphate (CSP) and rock phosphate (RP) addition an conventional and organic management on Mehlich 3 extractable P.

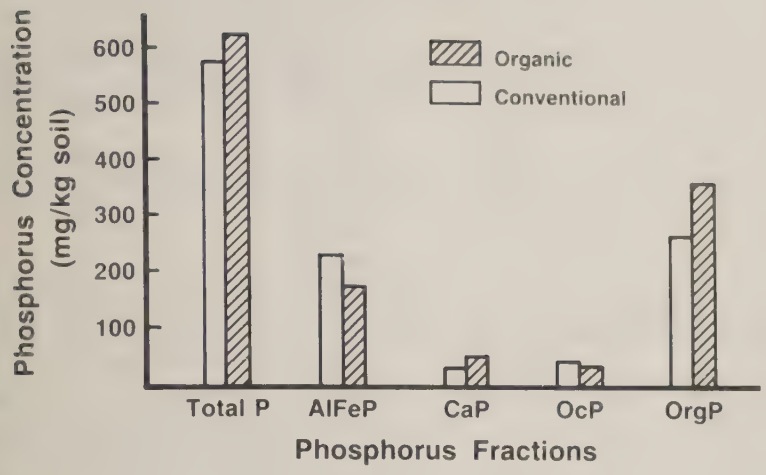

Figure 5. The effect of management (conventional and organic) on the concentration of total P, aluminum and iron phosphate (AlFeP), calcium phosphate (CaP), occluded AlFeP (OcP) and organic phosphorus (OrgP); data from the control soils. All differences significant at the 1% level of probability.

Analysis to determine soil P fractions in soil from the control and high rate of each management and source combination was performed. Treatment main effects were significant for all fractions except OrgP (Table 3). The organically managed control soil had significantly greater total P, CaP, and OrgP and significantly less AlFeP and OcP than did the conventionally managed soil (Figure 5). Greater CaP and OrgP in the organic system may have resulted from past use of RP and organic P sources in the organic system but not in the conventional system.

As expected, CSP and RP additions influenced the P fractions differently. The CSP significantly increased AlFeP and OcP over the controls and had little effect on CaP levels (Figure 6). In contrast, RP significantly increased CaP and OcP levels over the controls but had no effect on the AlFeP levels. Neither amendment affected OrgP levels. The differential effect of the P source on soil P fractions reflects the reactions of these sources in the soil. Readily available P sources tend to be removed from solution and precipitated as AlFeP compounds very rapidly while insoluble sources, such as RP, are largely unreactive (Sample et al., 1980).

Stepwise multiple regression analysis was performed on data from the control and high-rate treatments to identify P fractions that could predict extractable P, plant yield, plant P concentration, and P uptake. Regressions were performed on the source x management data (i.e. data averaged over P applications rates).

Regression analysis of the plant data showed that yield and leaf P concentration were not significantly related to the soil parameters measured except in the CSP-amended soils (Table 4). Difficulty in modeling yield and leaf P may have occurred because soil P differences in the RP-amended soils and within each rate are small and the range in P values too narrow to elicite a response to these variables. For extractable P, models which had significant terms were generated for all variations of source x management (Table 4). In CSP amended soils, AlFeP predicted extractable P while CaP best predicted extractable P in RP amended soils. This high correlation between extractable P and AlFeP, when using extractants containing dilute acid plus ammonium fluoride (NH_4F) has been noted by many researchers (Kamprath and Watson, 1980). In acid soils low in CaP, dilute acid plus NH_4F extractants are selective for AlFeP but in acid soils high in CaP these extractants solubilize both CaP and AlFeP (Kamprath and Watson, 1980; Martens et al., 1969). This explains the high correlation between CaP and extractable P for the RP-amended soils.

The Fertrell treatment was included in the greenhouse experiment to represent the current fertilization practice used on the organic farm. No significant differences in any of the plant or soil parameters measured were found between the control soil and the soil amended with Fertrell in either management system (data not shown). However, at the rate used, this amendment does provide 63 kg of total P/ha in the form of CaP and organic materials. This

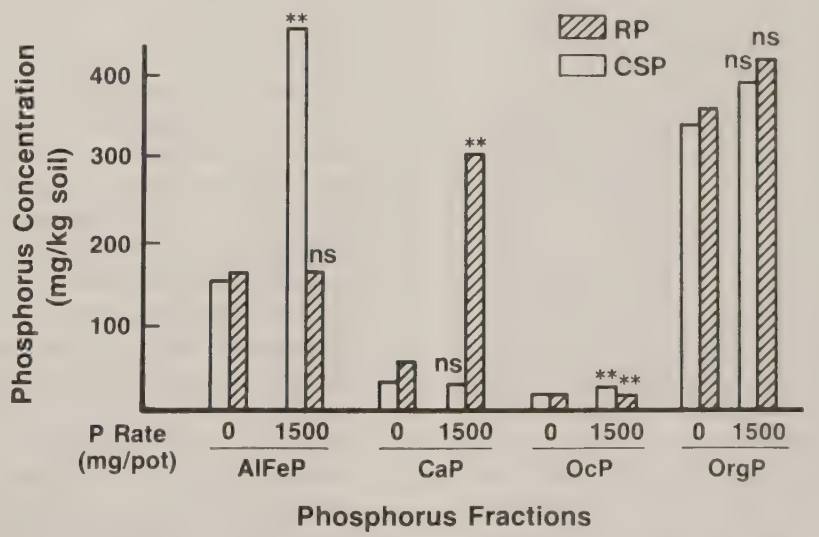

Figure 6. The effect of P source (concentrated superphosphate [CSP] or rock phosphate [RP] and P addition on aluminum and iron phosphate [AlFeP], calcium phosphate [CaP], occluded AlFeP [OcP] and organic phosphorus [OrgP]) data from the control and high rate treatments. For a given soil P fraction and P source, ** indicates the effect of source was significant at the 1% level of probability. "n" indicates that differences were not significant.

Table 4. Results of stepwise multiple regression analysis of data averaged over P application rate. Results presented are for the model: dependent variable = extractable P (XP), AlFeP, CaP, OcP and OrgP. R^2 values and independent variables for significant models are presented.

		Dependent Variables[+]									
		Yield		P uptake		Plant P conc.		Leaf P conc.		Extractable P	
Source[‡]	Method	R^2	Independ. variable[≠]	R^2	Independ. variable	R^2	Independ. variable	R^2	Independ. variable	R^2	Independ. variable
CSP	Conventional	0.78	XP	0.97	XP	0.98	XP	0.97	XP	0.99	AlFeP
	Organic	0.84	XP	0.93	XP	0.98	XP	0.52	XP	0.99	AlFeP
				0.99	XP-AlFeP						
RP	Conventional	ns[Δ]		0.57	XP	0.51	XP	ns		0.99	CaP
	Organic	ns		0.77	XP	0.60	XP	ns		0.84	CaP

[+] Dependent variables: total dry matter yield (Yield), total P uptake at flowering (P uptake), P concentration in above-ground plant (Plant P conc.), P concentration in the most fully developed trifoliate leaf at flowering (Leaf P conc.), Mehlich 3 extractable soil P (Extractable P or XP).

[≠] Independent variables: Mehlich 3 extractable soil P (XP), aluminum and iron phosphate (AlFeP), calcium phosphate (CaP), occluded AlFeP (OcP) and organic phosphorus (OrgP).

[‡] CSP: concentrated superphosphate. RP: rock phosphate

[Δ] All models significant at $P \leq 0.05$ unless indicated by "ns" (not significant).

source of P may be made available to plants in amounts sufficient for crop production over a period longer than that of the greenhouse experiment.

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Alternative farming systems center

An alternative farming systems information center has been established by the National Agricultural Library, a USDA institution at Beltsville, Md. An announcement said the center provides access to information services and publications "covering a variety of non-traditional agricultural practices and systems that emphasize low-input, resource-conserving farming and gardening."

Director Joe Howard said the center is one of several set up recently to serve current users better and to reach new user groups. He said NAL works with state and federal agencies, support groups in industry, and the scientific community in establishing these information dissemination centers. The Institute for Alternative Agriculture provided assistance in setting up the new alternative farming systems center.

A food and nutrition center that has operated successfully since 1981 is the model for the new centers. It provides reference services (including referral service and computer searches of major databases when necessary), is a national demonstration center for food and nutrition microcomputer software, loans books and audiovisuals, and provides photocopies of journal articles.

Other new centers opened recently cover food irradiation, aquaculture, biotechnology, and critical agricultural materials. The NAL is the coordinator and primary resource for a national network of state land grant and field libraries and serves agricultural libraries nationwide.

More information can be obtained by writing the Alternative Farming Systems Information Center, National Agricultural Library, Room 111, Beltsville, MD 20705.

A cropping systems approach to salinity management in California

Kenneth G. Cassman and D. William Rains

Abstract. *In irrigated cropland of the semi-arid and arid regions of California, the lack of drainage outflow requires reassessment of crop rotation patterns. As regulatory actions place limits on drainage water quality and quantity, growers will be forced to manage water more efficiently and rely more heavily on salt-tolerant crops. Improved water use efficiency depends on integrated cropping systems in which cultural practices interact to reduce leaching requirements while maintaining productivity, profitability, and the environment. The success of this approach will require a better understanding of the physiological basis of plant salt tolerance and the evolution of soil properties as influenced by crop rotation, tillage, crop residue and soil fertility management. An increased commitment to evaluate such interactions in long-term field studies is needed.*

The most productive agricultural domain in California is the San Joaquin Valley, which includes some 2,300,000 ha of irrigated farm land. About 10% of the irrigated acreage is severely affected by soil salinity and it is projected that salinization will adversely affect more than 500,000 ha by the turn of the century (Backlund and Hoppes, 1984; Beck, 1984). Ironically, it is the high productivity of agriculture in this semi-arid environment which leads to salinity problems since crop water use and biomass production are closely linked. Thus, even when high quality irrigation water of low salt content is utilized, more than 2000 kg salt/ha is applied annually to irrigated summer crops such as cotton (*Gossypium hirsutum* L.) or alfalfa (*Medicago sativa* L.).

The detrimental effects of increasing salinity result from alteration of soil physical, chemical, and biological properties. Soil structure, porosity, plant-available nutrient and water supply, and microbial populations are affected by salt concentration and distribution in a soil profile. These properties in turn are also influenced by cultural practices other than irrigation and thus the net impact of salinization will reflect both salt balance and crop management over time. Unfortunately there has been relatively little research concerning the long-term effects of present crop management systems on the evolution of soil characteristics in salinity-prone areas of California. Several crucial issues are involved. Are present cropping systems on saline soils sustainable without increased resource use per unit output? Why do growers apply more irrigation to crops than what is required for maximum yields (Hoffman et al., 1984a; Hoffman et al., 1984; Lonkerd et al., 1979)? Are present crop rotations and crop management practices improving, maintaining, or degrading the soil properties which are important determinants of productivity and resource use efficiency on saline soils? Certainly an integrated and interdisciplinary research effort is a requisite if such complex issues are to be examined under field conditions. In this paper we will argue that it is also important to evaluate these relationships within the framework of the cropping system.

In presenting our perspective, we are assuming that the primary goal is to develop crop production systems which minimize saline drainage, maximize water use efficiency (WUE, defined as g H_2O applied per unit usable produce or economic yield) and are economically viable. These assumptions reflect the lack of an outflow drainage system in the San Joaquin Valley and concern over salinity levels in the lower Colorado River basin and the Salton Sea. Obviously, the law of conservation of mass dictates that sooner or later excess salts must be removed from the system. But from our view, maximizing efficient use of water and minimizing drainage water will determine the economic viability of alternative management systems. The objective of this review is to evaluate components of management strategies and important interactions which influence water use, salt accumulation, and the impact of salinity on crop performance in irrigated cropping systems of California's Central Valley.

Integrated crop management research

There have been long-term, integrated crop management research programs which have successfully addressed salinity-related problems in the Northern Great Plains and we will consider these efforts as a model. Saline seeps have become quite extensive in the semi-arid regions of the Northern Great Plains (Miller, et al., 1981), causing reduced production of cereal grains and other crops (Ferguson and Bateridge, 1982).

In these rainfed areas a two-year crop-fallow rotation is commonly practiced. Improved weed control in fallow years resulted in increased soil moisture storage. This additional moisture is available for next year's crop but any excess water supplies greater leaching volume through the profile and ultimately flows laterally down slope carrying soluble salts into saline seeps. A major effort was initiated to develop management

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practices which reduce water movement below the root zone and into the seeps. This required information on: (a) water availability at any given time, (b) crop water requirements, (c) rooting depths of specific crops, and (d) water additions to the soil profile. The quantity, depth and salt content of available soil water are also important parameters in this system. As salinity increases, rooting depth and water use decrease. Crop rotations were matched to the supply of stored soil moisture. A combination of deep rooted crops such as alfalfa, safflower (*Carthamus tinctorius* L.), or sunflower (*Helianthus annuus* L.) were included in the rotation to deplete water at greater depths followed by shallow rooted crops to intercept and utilize water near the soil surface.

Long-term studies by Black et al. (1981) identified other management practices which enhanced crop water-use efficiency and helped control the amount and distribution of water and salt in the profile. Several cropping systems were compared over a 12-year period for water use efficiency and for grain yield per unit of rainfall (Table 1). Annual cropping systems included rotation of winter wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.), and safflower. Fallow systems followed an alternative year winter wheat-fallow rotation. The annual cropping system had a higher water use ratio (annual soil moisture depletion/annual precipitation) per cropping cycle and greater grain yield/per unit precipitation than the alternate year fallow system. Proper nitrogen fertilization also improved water use efficiency.

A number of crops were used in these rotation systems. Safflower was found to extract soil water at greater soil depths than other annual crops. Over a 3-year period alfalfa was more effective in utilizing stored soil moisture: in the second and third years after seeding, alfalfa depleted existing soil water supplies from progressively deeper soil depths than did an annual safflower crop (Brown and Miller, 1978). Alfalfa cultivars were also found to differ in their ability to deplete stored water in the soil profile (Black et al., 1981). Of special interest was the observation that differences in profile water depletion were not related to above ground dry matter production.

Effective organic matter management focused on returning crop residues to the soil. This was found to improve physical and chemical properties including soil organic matter, soil nitrogen, soil carbon, available phosphorus, exchangeable potassium, nitrogen mineralization and dry aggregate soil structure (Black, 1973). Addition of straw mulch to a bare-fallow, salt-affected soil significantly altered its chemical characteristics. Increased microbial activity decreased the pH of the soil, enhanced nitrate concentration, and increased solubility of calcium carbonate. A decrease in pH and an increase in mobile Ca^{++} are two factors involved in reclamation of saline/alkali soils (Pakshina, 1983).

Cropping systems are patterns and sequences of crop production, resource allocation, and crop management over time and space on a given farm unit. On irrigated soils prone to salinity problems in California, three types of cropping systems are found, namely, (i) field crops, (ii) vegetable and melon crops and, (iii) perennial fruit and nut crops. Of these, irrigated field crop systems predominate and this paper will focus on these systems although much of what is covered also applies to vegetable, melon, and perennial systems.

While California's mild climate a abundant water resources permit cu vation of numerous crop species, basic structures of all field crop syste are similar. Though crop rotations va they are comprised of an irregular quence of dominant and secondary cr (Table 2). The dominant crop is of p mary concern to the farmer. It is higher value than secondary crops a thus a grower manages a crop rotati to maximize production and retu from the dominant crop. Dominant fi crops include cotton, rice (*Oryza sat* L.), and processing tomato (*Lycoper con esculentum* L.) although in so areas alfalfa, sugarbeets (*Beta vulga* L.), and dry beans (*Phaseolus vulga* L.) may also function as dominant cr in the rotation. Secondary crops inclu wheat, corn (*Zea mays* L.) for grain silage, barley, safflower, and sorghu (*Sorghum bicolor* L.). Alfalfa is a s ondary crop commonly used in rotati with cotton or processing tomato.

Factors which determine the need rotate out from a dominant crop va depending on cropping system and gion. On salt-affected soils derived fr granitic alluvium in the central San J quin Valley, soil compaction and dra age problems, an encroaching wa table, or disease often dictate the ne to rotate out of cotton. Some farmers Tulare Lake soils follow a regular tation with two or three consecutive c ton crops followed by a winter-spri safflower crop which helps control encroaching water table. Safflower is rigated once at planting and relies water extraction from a deep root syst which lowers the water table some 20 40 cm. On the west side of the San J quin Valley soils are derived from s imentary alluvium and growers rot out of dominant crops such as cott tomatoes, melons, or vegetable cr when disease or weed pressures redu yields.

Although rotation intervals are irr ular, the pattern of dominant-seconda crop rotations has been consistent o the past 40 years. There has, howev been a steady increase in the proporti of acreage in higher value domina crops. All of the dominant crops a

Table 1. Comparison of water use ratio and grain yield per unit precipitation in annual or alternate year crop/fallow cropping systems over a 12-year period (modified from Black et al., 1981).

Cropping System	Water Use Ratio†	Grain Yield Unit of Precipitation kg/mm	
		ON	34 kg N/ha
Annual cropping††	0.80	3.4	4.5
Winter wheat-fallow	0.50	2.6	3.1

† Water use ratio is total crop soil moisture depletion/total precipitation for each crop cycle.
†† Includes 6 consecutive winter wheat crops followed by barley, safflower, barley, winter wheat, safflower, and barley.

Table 2. Common crop rotation patterns for cotton-, rice-, and processing tomato-based cropping systems in California.

Year	Cotton Systems		Rice Systems		Tomato System
	Central SJV	Westside SJV	Basin Clay Soil	Terrace Soil	Yolo County
1	Cotton	Cotton	Rice	Rice	Tomato
2	Cotton	Cotton	Rice	Rice	Tomato
3	Cotton	Wheat*	Rice	Corn	Wheat*
4	Alfalfa	Cotton	Fallow	Rice	Corn
5	Alfalfa	Cotton	Rice	Wheat*	Tomato
6	Alfalfa	Cotton	Rice	Rice	Wheat*
7	Cotton	Tomato	Fallow	Rice	Tomato
8	Cotton	Wheat*	Rice	Rice	Sugarbeet
9	Wheat*	Cotton	Rice	Wheat	Tomato
10	Cotton	Cotton	Rice	Fallow	Tomato

* Wheat planted in late fall of the proceeding year and harvested in June or July of the following year. This results in a summer fallow period.

summer crops and, except for cotton, they are more sensitive to soil salinity than the winter cereal secondary crops they displace. The availability of low salt content water was a prerequisite for this shift. Construction of the Central Valley Project in the 1940s and the California Aqueduct in the late 1960s provided good quality canal water to large areas in the San Joaquin Valley. In Kings County, for example, winter cereals were grown on 55% of the 183,000 ha of irrigated crops in 1964 to 1968 (Table 3). By 1984, winter cereals represented only 22% of a comparable 190,000 irrigated ha. For the same reason there has also been a large increase in acreage devoted to perennial fruit and nut crops. These trends have increased the water use and drainage requirements and greatly affected the salt balance in the San Joaquin Valley.

The ideotype crop for crop rotations on saline soils

The lack of drainage outflow from the San Joaquin Valley may require reassessment of crop rotation patterns. Certainly as regulatory actions place limits on drainage water quality and quantity, growers will be forced to manage water more efficiently and rely more heavily on salt tolerant crops. The introduction of new, alternative crops and genetic improvement of present crops to better tolerate a saline environment are worthy objectives. In both cases four characteristics are desired. These are:

1. A high water use efficiency (WUE as defined earlier).
2. Tolerance of high soil salinity levels in the root zone at germination and emergence as well as during later growth.
3. The ability to extract water against a high soil water salt concentration.
4. Extensive root systems which grow deeply in the soil profile.

Taken together these attributes will provide significant advantages in a cropping system on a saline soil.

Crops with a high WUE produce a greater output per unit water input. On saline soils the free depth of irrigation water applied to a crop (D_{iw}) must meet the consumptive water use (D_c) plus an added increment to maintain a tolerable level of salinity in the root zone via leaching. This added increment can be considered the equivalent depth of water which passes through the root zone, or ultimately leaves the field as drainage water (D_{dw}). Total applied irrigation water can be expressed as:

$$D_{iw} = D_c + D_{dw} \quad [1]$$

All else being equal, crops or genotypes with higher WUE will have lower consumptive water requirements and thus less salt would be added with the irrigation water to the soil system.

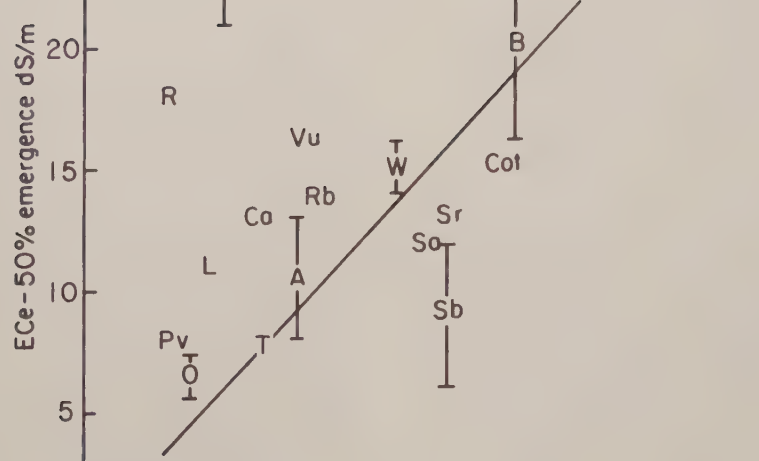
For a given crop, high WUE may be associated with earliness and rapid canopy cover. Earliness in a winter crop such as wheat would shift the period of greatest water demand (i.e., late vegetative and early reproductive growth stages) earlier in the spring when potential evapotranspiration is low. Likewise, for summer crops, early maturity may permit one less irrigation during the late reproductive growth stage in August or September.

Rapid canopy closure and earlier attainment of optimal leaf area would also improve WUE. At low leaf area indexes (LAI) the transpiration rate per unit leaf area is high due to greater solar radiation per leaf and higher canopy air temperatures from thermal radiation by the heated soil surface exposed to sunlight (Loomis, 1983). Higher plant populations with closer inter-row spacing is one management tool which can be used to

Table 3. Average annual area planted to winter and summer crops in Kings County from 1955 to 1984†.

Period	Winter Crops				Summer Crops					
	Cereals	Safflower	Misc.	Total	Seed Crops	Alfalfa	Cotton	Fruit/Nuts	Misc.	Total
	ha × 1000									
1955-59	85	—	3	88	1	19	39	3	6	68 (44)††
1964-68	77	16	8	101	3	25	36	4	14	82 (45)
1970-74	66	13	8	87	3	24	59	4	16	106 (55)
1978-82	59	14	8	81	12	19	117	9	13	170 (67)
1984	29	9	4	42	10	11	108	9	10	148 (78)

† These data obtained from Kings County Annual Crop Reports (1955 to 1984), Kings County Department of Agriculture, Hanford, California.
†† Numbers in parentheses are total summer crop acreage as a percentage of total winter and summer crop acreage.



B - Barley Cot-Cotton Sb-Sugar beet Sr-Sorghum
So-Safflower W - Wheat Rb-Red beet Vu-Cowpea
A - Alfalfa T - Tomato Ca-Cabbage M-Corn
L - Lettuce O - Onion R - Rice Pv-Common bean

Figure 1. Critical threshold mean root zone salinity levels for various crop species at emergence and for yield. Vertical bar intervals indicate reported range for different genotypes within species. The diagonal line represents an equivalent critical threshold for emergence and yield (adapted from Shannon, 1982).

promote earlier canopy closure. This often requires selection of crop genotypes which are adapted to higher densities. For example, with 75 cm inter-row spacing Acala cotton variety SJ-2 attains highest yield at 50,000 to 75,000 plants/ha and lint yield is significantly reduced at higher densities. In contrast, the experimental line SS-2086 produces highest lint yield at 120,000 to 150,000 plants/ha (pers. communication, T. Kerby). At optimal densities, line SS-2086 yields 10% more lint than SF-2 although both cultivars have similar total biomass. While comparative WUE of SJ-2 and SS-2086 have not been evaluated, it is likely that adaptation to higher density and early canopy closure would increase the WUE of line SS-2086.

Crop tolerance of root zone salinity, usually measured as electrical conductivity (EC, dSm^{-1} at 25°C) in a saturated soil extract (EC_e), confers a second advantage in managing crops in saline environments. Under steady-state conditions, many studies have demonstrated a good correlation between average root zone EC_e and crop performance (Maas and Hoffman, 1977). Root zone EC_e levels are largely determined by the salt content of the irrigation water. Thus increased crop tolerance of root zone salt levels permits use of irrigation water with higher salt content. Or, where regulatory controls limit off-farm drainage, root zone salinity tolerance would allow greater recycling of saline drainage water.

The literature is replete with reports on plant response to root zone salinity and considerable effort has been focused on evaluating the degree of genetic variability in this response. Frequently plants show changes in salt tolerance with changes in ontogeny. Some species are more tolerant during germination and less tolerant to salt during later stages of the life cycle (Figure 1). These data suggest that it would be possible t select crops for tolerance to salinity a both emergence and early developmer as well as during later growth stage (Shannon, 1982).

The ideal crop for saline soils woul also be deep rooted and be able to extrac water against high salt concentration i the soil solution. Taken together, thes two characteristics will determine th active crop root zone when irrigatio water salt content is constant and leach ing irrigation increments are minimized The minimum leaching requiremer (LR_{min}) is defined as:

$$LR_{min} = D^{*}_{dw}/D_{iw} \qquad [2$$

where D^{*}_{dw} is the minimum depth of ap plied irrigation water, in excess of cro consumptive water use, which is re quired to maintain root zone salinity be low the critical threshold level at whic yields are reduced (see equation 1). So solution salinity increases with dept and, just below the root zone approaches the maximum salt concen tration against which the crop can ex tract water (EC_{emax}). At steady-state, th EC_{emax} would approximate the salt con centration of water which passes belo the root zone as drainage water (Bern stein and Francois, 1973; Bower, 196 Lonkerd et al., 1979; Van Schlifgaard et al., 1974).

Reported values of EC_{emax} for severa crops suggest that there are considerabl differences among plant species in th trait (Ayers and Westcott, 1976). How ever the rankings of crop tolerance t mean root zone EC_e are not the same a their rankings with respect to EC_{ema} which indicates that the physiologica determinants of these two characteristic differ. Although intraspecific genotyp variation to EC_e levels have been wel studied, little information exists on in traspecific variation in EC_{emax}. Assumin an exponential water uptake functio from a salinized soil profile at steady state (Hoffman, 1985; Raats, 1974) crop cultivar with a high EC_{emax} will e tract both water and nutrients from larger effective root zone than a com parable cultivar with a lower EC_{emax}.

For a given crop with a genetical determined EC_{emax} and threshold E tolerance in the root zone without yie

reduction, the frequency of irrigation will depend on the depth of the active root zone and the water-holding characteristics of the soil. In a lysimeter study, Bernstein et al. (1975) demonstrated that when nutrient supply was not limiting, root zone depth is not critical if an LR_{min} is used with frequent irrigation to replace consumptive water use. However, under field conditions frequent irrigation is costly and difficult. As rooting volume (and thus plant available soil water storage capacity) is reduced, irrigation timing becomes more critical as the crop water demand/soil water storage ratio increases. A large rooting volume would facilitate irrigation scheduling by providing a wider margin for error. This would be more important where root zone EC_e was high since higher salt concentrations increase the osmotic potential of the soil solution and reduce the actual availability of stored soil water.

Most of the current research on selecting crops and crop genotypes for saline environments has focused on increased tolerance to mean root zone salinity. Much less attention has been given to selection for higher WUE, ability to extract water against high soil solution salt concentration, or favorable rooting patterns. Expanding the focus to include all four attributes may increase the probability of developing improved crops for saline soil.

Definition and management of the root zone

Although crop salinity tolerance and irrigation management are important components of crop management systems on saline soils, cultural practices which influence root zone soil properties are equally important. Conventional management practices have largely relied on addition of soil amendments, such as gypsum, and deep ripping to ameliorate water and root penetration problems which are often associated with salt-affected soils. Providing growers with a wider array of management alternatives has been limited by our rather primitive understanding of the root zone environment.

Root zone volume and soil water storage capacity determines irrigation frequency. Given a specified LR_{min}, irrigation water of a known salt content, and a crop with a known threshold EC_e for maximum yield, irrigation and drainage can be precisely controlled only when the actual root zone depth is known. While several investigators have examined crop rooting patterns under field conditions (Grimes et al., 1975; Hoffman et al., 1984a; Hoffman et al., 1984b; Lonkerd et al., 1979) the ability to define and predict the "effective rooting volume" (ERV) utilized by a given crop on a given soil is difficult at best. If recycling of saline drainage water is considered to be a viable option, then the ERV and soil water depletion limit in the root zone become the primary determinants of irrigation management.

Unfortunately the critical ERV for a specific crop cultivar depends on at least four soil parameters which are often extremely non-uniform. Soil water storage, fertility, compaction, and salinity characteristics vary in time, down a soil profile, and across a field. Geostatistical evaluation of the spatial association among these parameters may help in developing the predictive methods required to determine average ERV values for a given field (Greminger et al., 1985).

Improved water management in cropping systems on salt-affected soils will also require improved nutrient use efficiency and fertility management. As attempts are made to increase WUE by minimizing the leaching requirement, soil salinity levels will increase at lower soil depths. This leads to a reduction in the ERV and thus both water and nutrient storage capacity in the root zone are diminished. With a restricted root zone, modifications in fertilizer placement, fertilizer timing, selection of nutrient-ion form, and water management must be integrated to optimize nutrient use efficiency.

Salinity-related nutritional disorders resulting from ion uptake antagonisms and post-assimilation physiological mechanisms would also affect nutrient requirements and fertility management. Epstein (1985) suggested that breeding for salinity tolerance should be coupled with genetic and physiological research on all manner of other mineral nutrient stress and that more of these studies need to be conducted under actual field conditions. In fact, our present capabilities to predict cost-effective crop fertilizer requirements for N, P, and K are barely adequate under non-saline conditions. Much of the work on soil and plant nutrient status testing as a basis for fertilizer recommendations was conducted in the 1950s and 1960s on crop cultivars no longer in use, under crop management regimes which have been greatly modified, and at yield levels significantly lower than at present. Better definition of crop nutrient requirements and innovative fertility management of the root zone will be important components of salinity management systems.

Management of root zone salinity levels also depends on water passage through the ERV. In a recent evaluation of several factors which affect profitability on saline soils, Dinar et al. (1985) concluded that the influence of water infiltration uniformity is large when costs of drainage water disposal are high. Non-uniformity of soil permeability may explain, in part, why growers over-irrigate their crops (Hoffman et al., 1984a; Hoffman et al., 1984b; Lonkerd et al., 1979). Growers apparently apply more water than needed to insure that the slowly permeable patches within a field are also leached. In many cases these patches with lower infiltration rates represent a relatively small portion of total field area. But given the importance of infiltration uniformity, we know very little about the long-term effects of present crop management practices on this parameter. Major innovations such as laser leveling may have conflicting short and long-term effects, especially when subsoil is exposed: improved leveling will facilitate the control of water flow across a field but may also increase the non-uniformity in infiltration rates within the field.

Crop residue management, cover crops, and manuring also affect water infiltration. While there is little possibility of increased use of manure to ameliorate soil structure since more than 90% of all collectable manure is presently used on California's farm land (Rauschkolb and Mikkelsen, 1978), crop residue management and cover crop sys-

Table 4. The characteristics of five green manure crops and their effect on the infiltration rate measured over a 28-month period.

Green manure species	Date of incorporation	Stage	Dry Weight of tops lb/acre	Nitrogen in tops %	Mean infiltration rate* inches/hr
Barley	April 30, 1959	Milk	7,120	1.37	1.40
Cereal rye	May 23	Milk	9,860	1.46	1.35
Annual ryegrass	April 30	Heading	3,820	1.82	1.30
Soft chess	April 30	Heading	3,980	1.86	1.13
Mustard	March 28	Blooming	4,090	3.43	0.89
Control	—	—	—	—	0.73
LSD 5%			1,250	0.39	.18

* Average of 9 tests over a 28-month period (Williams, 1966).

tems may provide useful management options. Cover crops have been shown to be very effective in increasing water infiltration rates on agricultural soils in California (Williams, 1966, Table 4) but we have not yet developed pragmatic management systems for implementation nor have we examined the economics of such systems. How much cover crop biomass is required? What are the critical limits for planting dates and plow-down? Would a salt-tolerant cover crop improve infiltration uniformity due to more even growth and dry matter production with non-uniform soil salinity distribution across a field?

Crop residue management may significantly influence water infiltration (Mazurak et al., 1955). For example, on many soils in the central San Joaquin Valley which are prone to salinity-related permeability problems, corn is often grown for grain or silage as a secondary crop in rotation with cotton. One might question the wisdom of total removal of all crop residue as in a silage crop; stover from an 8000 kg/ha grain crop would approach 9000 kg/ha. Williams (1966) reported a 34% and 125% increase in water infiltration rate in untraveled and traveled furrows, respectively, after corn crop residue (6000 kg/ha) was incorporated in a Yolo loam. But again, as with cover crop systems, little is known about the long-term effects and economic consequences of different crop residue management systems.

We do know that soil organic matter content varies considerably among fields with similar soil types in the San Joaquin Valley (unpublished data) and it is probable that crop rotation, residue management, and use of manures would affect the steady-state organic matter content for a given cropping system. Other evidence suggests that increased organic matter content in soil tends to counteract the unfavorable affects of exchangeable Na, improves soil structure, and reduces slaking (U.S. Salinity Laboratory Staff, 1954). Russell (1973) suggests that maintenance of decomposable organic matter levels increases soil permeability when irrigation water with a high sodium absorption ratio (SAR) is used on calcareous soils. Apparently, the higher CO_2 concentration in the soil atmosphere from active microbial populations reduces the pH of the soil solution. This results in increased solubility of Ca^{2+} and lowers the SAR of the soil solution in the root zone.

Conclusions

The primary focus of this paper is to evaluate the management of cropping systems in areas affected by salinization of agricultural soils. A major concern under these conditions is whether current cropping systems can be maintained and what factors influence their sustainability. Recognition and quantification of these factors could provide management alternatives for present cropping systems and identify specific manipulations required to reduce the impact of salinity on crop production. A number of agronomic practices are either being used or have been evaluated in saline affected areas. These include: (1) rotation systems; (2) tillage and residue management systems; (3) alternative or new crops, and (4) water and fertility management. We have briefly discussed some of these management alternativ and attempted to evaluate their potent ameliorative impact on crop producti ity and resource use efficiency. While economic analysis has not been tempted here, we recognize that t costs, returns, and risks associated wi improved management systems will di tate the rate of adoption by farmers.

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Agricultural sustainability in the 99th Congress

Record farm foreclosures, rising farm debt, falling commodity prices, declining export markets, shakeouts in the farm supply industry, and unprecedented government subsidy payments designed to prop up farm prices, have dominated agriculture headlines throughout the 99th Congress. Despite the unusually protracted and detailed hearings and related preparations for the 1985 four year farm bill, lawmakers and administration officials are now engaged in heated debates over the fiscal and economic merits, defects, and unanticipated consequences of this omnibus legislation.

Understandably, the importance and severity of the immediate short-term economic needs and problems of American agriculture have diverted public attention away from the actions of the 99th Congress related to the emerging issue of long-term agricultural sustainability. Yet, this Congress did begin to address these issues in a number of important and innovative ways.

Of greatest interest to the readers of the *American Journal of Alternative Agriculture* was the inclusion of specific agricultural productivity language in sub-section c of title 14 of the 1985 farm bill. The so-called Agricultural Productivity Act, is the first explicit alternative farming systems research and education legislation ever passed by Congress. The original proposal, first introduced in 1982, was drafted to implement major recommendations of the 1980 report on organic farming prepared by a USDA study team. Its primary sponsors, James Weaver (D-OR) in the House and Patrick Leahy (D-VT) in the Senate, demonstrated lawmaking skill in getting the bill through both houses of Congress in less than a year. Compromise language worked out in 1985 in the House Agriculture Committee defused much of USDA's opposition to the bill. Despite its sponsors and supporters continuing efforts, no action has yet been taken to fund this legislation. Also, it remains to be seen what measures USDA will take to implement various aspects of the bill.

Although the bill's language is quite general, this measure has a long and detailed legislative history. Two sets of hearings in the House and one in the Senate, plus several committee reports and letters, make the intent of this legislation clear. Research projects on three types of farming systems are its most important and innovative feature. It is the intent of this legislation to carry out these research projects on farms using conventional technology, farms in transition from conventional to alternative methods, and farms that have used alternative methods for at least five years. Each farming system project would include twelve or more farms, last a minimum of five years, and continue as long as fifteen years if necessary to obtain complete evolutions of various cropping and management systems. A panel of USDA-appointed scientists would design and implement the projects in cooperation with agricultural universities and other qualified agricultural organizations and individual researchers. Many land grant university scientists have expressed interest in being involved in these projects.

The urgent need to address the long term sustainability of American farm land was reflected in a number of other major farm bill provisions, including new authority for significant soil and water conservation program initiatives. A conservation reserve of up to forty-five million acres of highly-erodible cropland, similar to the Soil Bank of the 1950s, is one of its most important features. Under this program, farmers put eroding cropland into soil-conserving uses for periods of ten to fifteen years under contracts obtained through a USDA bid process. In return for annual payments, farmers agree to put reserve acres into grass, legumes, or trees. The reserve is seen as a way to combat both heavy soil loss and surplus production.

The farm bill also includes a sodbuster provision which denies government price and income supports to farmers who produce crops on newly-plowed fragile land, a swampbuster provision that denies these benefits to farmers who convert wetlands to agricultural use, and a new conservation easement program which allows USDA to acquire long-term easements on farmland mortgaged to the Farmers Home Administration. In return for reducing the debt load, the land covered would be managed for conservation, recreation and wildlife.

That the 99th Congress, beset with so many urgent farm-related economic problems, chose to devote this much legislative time and explicit resources to the conservation and improvement of America's farm lands and farming technologies, testifies to the growing importance of the issue of long-term agricultural sustainability in America. Appropriately, it reflects broad and deepening societal concerns over the future of agricultural sustainability, a concern now shared by a growing number of farmers, agricultural scientists, educators, and administrators.

Farmers' opinions about third-wave technologies

Paul Lasley and Gordon Bultena

Abstract. *This paper examines farmers' opinions about eight relatively new technologies. Data from a statewide sample of Iowa farmers provide the basis for examining the correlates of support for new technology. Evidence from a series of statewide surveys indicates that farmers are becoming concerned about environmental problems associated with conventional agricultural practices and are interested in alternative production systems. The data show that some new technologies are widely supported among farmers; in other cases farmers expressed considerable hesitancy or opposition to them. This paper draws on previous adoption research to examine the differential support of these technologies among farmers. From this earlier research two sets of variables, personal characteristics and farm characteristics, have been found to be important predictors of farmers' opinions about new technology. The analysis from new data shown here finds generally weak relationships between personal and farm characteristics with level of support for new technologies. Given the generally weak relationships between personal and farm characteristics and support for new technology, the paper argues that other factors need to be included in future research on the adoption of new technology.*

Much has been written about the structural transformation of U.S. agriculture, especially the expanded size of farm operations. A major source of this transformation has been the rapid diffusion and implementation of new, innovative agricultural technologies. The shift from labor-intensive to capital-intensive farming operations has gone through three distinct phases. The first, the "mechanical revolution," was brought about by labor scarcity, demands for greater efficiency, and a desire to reduce the drudgery of pioneer farm life. This phase generally is thought to have begun in the mid 19th century. This revolution brought about the replacement of human and draft animal power with machines like the steam engine and, finally, tractors powered with petroleum-based fuels.

The second phase of structural transformation involved the substitution of energy and petrochemicals for mechanical practices. The petrochemical revolution began in the 1940s and reached its zenith in the 1970s. During this phase, agriculture has become highly dependent on fossil fuels (Perelman, 1977). Key innovations from this revolution include chemical fertilizer, especially nitrogen, and numerous herbicides and insecticides. Mechanical technologies have also become more pervasive and refined, leading to increased capital and energy intensification in agriculture.

It now appears that U.S. agriculture is on the threshold of a third wave of technology that will bring further mechanical and capital intensification and, in its wake, further alterations in rural social and economic structures. In particular, biotechnology, which permits a restructuring of genetic codes in plants and animals, holds promise of revolutionary changes in farming. Nitrogen fixation in corn and other grasses, for example, may greatly reduce the need for chemical fertilizers. Remaking annual crops into perennials may eliminate the need for soil cultivation and reduce soil erosion. Citrus crops are being developed that can grow in cooler climates and withstand cold snaps. The restructuring of genetic codes may make it possible for crops to be adapted to harsher environments. An ability to grow oranges in Iowa may also permit Utah to grow corn, suggesting that terms such as the "corn belt" or "cotton belt" someday may no longer be descriptive of regions where specific commodities are grown. Genetic engineering may als undermine the purebred livestock i dustry, relegating the status symbols e joyed by cattlemen to laborato scientists.

Historically, technology advances agriculture have been uncritically a claimed as good because they reduc drudgery and improved productivit But the technological revolutions ha not been without unanticipated, adver societal consequences. There is a lar research literature on the negative i pacts of new technologies. For exampl a recently published index of the articl published from 1936 to 1985 in the lea ing U.S. rural sociological journal, *Rur Sociology*, reveals that the effects of tec nology have the interest of social s entists (Rural Sociology 50 [Winte 1985).

Often critics of modern technolo have been viewed as "Luddites." Th label is drawn from the group of Engli workers who during the Industrial Re olution sabotaged textile machines th were taking their jobs. In the last fe years, however, a number of influenti government reports have documente some of the societal costs associated wi technology. During the time Bob Ber land was Secretary of Agriculture, f example, the U.S. Department of A riculture issued three major report *Structure Issues of American Agricultu* (1979), *A Time to Choose* (1981), a *Another Revolution in U.S. Farmin* (Schertz, 1979) on the changing stru ture of agriculture and the role of tec nology in the restructuring taking plac The latest and perhaps most unsettli government report on how technolo contributes to structural changes in a riculture is the Office of Technology A sessment's report, "*Technology, Pub Policy and the Changing Structure of A riculture*" (1986). This report moves b yond a discussion of the historical tren in agricultural structure and technolo

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to make some ominous predictions about the future. The report predicts that the emergence of new technologies, combined with existing forces of structural change, will cause the number of farms to decline from 2.2 million to 1.2 million by the year 2000. It also predicts that about 50,000 of the remaining 1.2 million farms will account for 75 percent of production, with much of this made possible through developments in biotechnology that enable agricultural production to become more centralized and vertically integrated.

The OTA report (1986) and Buttel (1985), among others, also raise important ethical issues about the potential adverse effects of biotechnology on family farming and rural communities. The adjustments that may be required as new technologies are developed and implemented pose important issues about the future viability of family farming and the quality of rural living. Increased food production, for example, may be an important societal goal in times of scarcity. But when large surpluses abound with low prices and extensive off-farm migration, lower priority perhaps should be given to increasing yields. Robotics, or computer-assisted machinery, may be attractive to some. With high rural unemployment rates and a continued substitution of capital investments for labor, however, it could prove socially dysfunctional by contributing to additional displacement of farm laborers and family farmers.

In addition to these prominent reports on the likely negative impacts of new technologies, the farm crisis that currently grips agriculture may be contributing to misgivings farmers have about some of the new capital-intensive technologies. It is during periods of crisis, when existing ways of doing things are not sufficient, that people are more receptive to trying new ideas and methods. It is plausible that the farm crisis, coupled with mounting evidence of the negative consequences of technology, may bring heightened awareness among farmers of the unanticipated costs of technology and may contribute to greater receptivity to alternative technologies. There is evidence, for example, that farmers are becoming increasingly concerned about environmental problems associated with current agricultural practices and may be more receptive to low-cost, low-input sustainable agricultural systems.

Evidence of change

Recent data gathered from Iowa farmers provide evidence of growing support for alternative agricultural systems and production methods. In the fall, 1983, Iowa Farm and Rural Life Poll, for example, 34 percent of 2,011 randomly selected farmers ranked runoff of pesticides and fertilizers as the single most important source of water pollution in the state. An additional 16 percent ranked soil erosion sediment as the primary cause of water pollution (Lasley, 1983). In the same survey, 75 percent supported diversifying Iowa's agriculture through encouraging alternative crops to be planted and marketed. More recently, 47 percent of Iowa farmers participating in the fall, 1984, Iowa Farm and Rural Life Poll supported allocating additional government research monies to assess the feasibility of organic farming methods (Lasley, 1984). In the 1985 spring poll, 69 percent endorsed diversification of agricultural production to include specialty crops as a needed direction for economic development in the state (Lasley, 1985).

These data suggest that many Iowa farmers are concerned about environmental problems resulting from current farm practices, are supportive of boosting research on organic farming methods, and feel strongly that agricultural diversification is needed.

In addition to these survey data suggesting that a radical paradigm shift is imminent is the recently announced national conference on agricultural diversification being sponsored by *Successful Farming* magazine (Muhm, 1986). Quoting Rich Krumme, editor for the magazine that is investing $250,000 in the conference, "We will offer farmers ideas to rise individually from the ashes of a badly burnt agriculture." Rather than focusing on traditional crops, the conference will look at such things as deer, snails, catfish, crawdads, gourmet birdseed, and alligators as ways to restore profits to farm families. "The idea according to Krumme is to 'try something different' rather than cling stubbornly to farming operations that have obviously been losing money." While this conference is not the first to examine the feasibility of alternatives, it is perhaps the first time that a major farm publication is willing to make such a radical departure from tradition. Quoting the *Des Moines Register* Farm Editor, Don Muhm, "The magazine will be abandoning for the first time being the mainstream agricultural gospel of livestock, crops and good farming one expects from a farm journal, the kind of traditional message *Successful Farming* has been preaching from its Des Moines offices for nearly 85 years."

Although the number of organic farmers or the number of conventional farmers who are at least interested in alternative technologies and crops is not known, there is growing evidence that the numbers are increasing (Youngberg and Buttel, 1981).

It is becoming evident that the future debate over the desired structure of agriculture will be inexorably linked to types and availability of technology. The discussions on the changing structure of agriculture, the role of technology in shaping the structure of farming, and its contributions to the farm crisis suggest that more farmers may be receptive to alternative technologies and production systems. The events of the past decade are eroding blanket endorsements of modern technologies or, at least, are causing some farmers to seriously question the merits of what has often been considered benign or size-neutral technologies.

Acceptability of new technologies

Much of the research seeking to explain the adoption of new technologies by farmers has drawn upon the classical adoption-diffusion model (Rogers, 1983). An often implicit assumption of that model has been that new technology is desirable and that the speed of its adoption can be accelerated through knowledge of farmers' decision-making processes and behavior. Individual adoption is typically viewed as being vol-

untary and as instrumental to improved personal well-being. But there is growing evidence that adoption doesn't always reflect positive assessments or psychological acceptance; some technologies are adopted because of external pressures or necessity. Many dairy farmers, for example, were forced to install bulk milk tanks or leave the industry. The required adoption of bulk tanks had nothing to do with whether or not farmers liked the technology. Dairy farmers in the near future may feel forced to use the recently announced bovine growth hormone, which is expected to raise milk production by 40 percent, if they are to remain competitive. Similarly, increased use of chemical herbicides may result from "reluctant adoption" because some farmers, despite concerns about health hazards and environmental degradation, perceive that chemical treatments must be used to remain competitive. Other examples of reluctant adoption include the use of medicated livestock feeds because of an absence of companies that sell unmedicated feed, and cross-compliance, which requires farmers to adopt soil conserving practices to be eligible for other government assistance. It seems that many of the new "third-wave technologies" may afford farmers little choice; they may have to be adopted to ensure economic survival in farming.

The classical adoption model has shown two major types of variables, personal characteristics and farm characteristics, are important in explaining farmers' adoption behavior (Van Es, 1985; Rogers, 1983). It is generally found that farmers who are younger, better educated, have higher incomes, and operate larger farms are the most likely to adopt innovative technologies. Consistent with these findings, we predict that age, education, income, and farm size will be correlated with farmers' acceptance of third-wave technologies.

Sample

Although data were not available to directly test the support of farmers for alternative agriculture, data were available to gauge their assessment of existing and emerging technologies.

Table 1. Farmers' Opinions About Innovative Technologies.

What are your views about these recent technological developments?	Strongly Oppose (1)	Somewhat Oppose (2)	Uncertain (3)	Somewhat Support (4)	Strongly Support (5)	Me Sco
	percent					
Energy production from feed grains and oils (E)	1	1	7	34	57	4.
Energy production from livestock wastes (E)	2	3	16	40	39	4.
Recombinant DNA research (genetic engineering research):						
on plants (DNA)	2	5	25	42	26	3.
on livestock (DNA)	4	6	27	43	20	3.
on humans (DNA)	23	13	35	20	9	2.
Robotics (computer assisted machinery) for on-farm use (HT)	20	21	28	24	7	2.
Confinement livestock facilities (HT)	10	20	20	38	12	3.
Personal computer for farm families (HT)	9	12	26	40	13	3.

(E) items included in the "energy" scale
(DNA) items included in the "DNA" scale
(HT) items included in the "high technology" scale

These data are from a statewide random sample of Iowa farm operators who participated in the Iowa Farm and Rural Life Poll. In the fall of 1984, 2,376 farmers were queried by mail questionnaire about their opinions toward eight new agricultural technologies. Questionnaires were received from 1,585 respondents, for a 67 percent response rate. Opinions about each technology were registered on a five-item, Likert scale that ranged from "strongly oppose" to "strongly support" (Table 1).

Findings

Technology assessments

Of the eight technologies, farmers were most supportive of alternative sources of energy. Ninety-one percent supported technology that would produce energy from feed grains and oils and 79 percent supported energy production from livestock wastes (Table 1). Three items dealt with DNA research on plants, livestock, and humans. There was moderate to strong support for DNA technology on plants (68% supported vs. 7% opposed) and for livestock (63% supported and 10% opposed). B DNA research on humans received su stantially less support. While 29 perce supported this research, 36 percent we opposed, and 35 percent were uncerta about its merits.

Robotics, defined for the responden as computer assisted machinery for o farm use, drew the highest proportio of opposition. Forty-one percent o posed this technology, 28 percent inc cated they were uncertain, and percent were supportive.

Confinement livestock facilities ar personal computers, two of the mo common agricultural technologies, we also included in the listing. While on half of the farmers supported confin ment livestock facilities, 20 percent we uncertain about its use and 30 perce indicated they were opposed. About on half of the respondents (53%) support personal computers for farm famili but, surprisingly, 26 percent were u decided about their merits and 21 pe cent indicated they were opposed.

These findings take on added signi cance in light of the often assumed wid spread acceptability of confineme facilities and farm computers amo farmers. It appears that a significa proportion of farmers hold some rese vations about even these "accepte farm practices.

Scaling the innovations

The next step in the analysis was to examine what personal and farm characteristics were related to farmers' opinions about these eight technologies. To facilitate the analysis, the responses to the eight technologies were factor analyzed to determine if there were underlying similarities in the response pattern. Three acceptable factors (eigen values greater than 1.0) were found (Table 2). These were: (1) an "energy factor" that included energy production from feed grains and oils and energy production from livestock wastes. Scores on this scale ranged from 2 (strongly oppose) to 10 (strongly support; Cronbach's alpha was .63); (2) a "DNA factor" that included the three items about DNA research on animals, plants, and humans. Scores on this scale ranged from 3 (strongly oppose) to 15 (strongly support; Cronbach's alpha was .68); (3) a "high-tech factor" that included three items about on-farm robotics (computer-assisted machinery, confinement livestock facilities, and personal farm computers). Scores on this scale ranged from 3 (strongly oppose) to 15 (strongly support; Cronbach's alpha was .72).

Independent variables

Two sets of variables--personal characteristics and farm characteristics--were posited to explain the respondents' opinions of the new technologies. Consistent with previous research, age was predicted to be negatively related to support of these technologies, and education and family income were predicted to be positively related.

Farm-firm characteristics included acres owned, total acres operated (acres owned plus acres rented), and gross farm sales. Consistent with previous findings on agricultural innovations, it was predicted that each of these characteristics would be positively associated with supportive attitudes toward the technologies.

Table 2. Summary of Technology Scales.

Scale	Number of Items	Alpha	Range	Average Score
Energy	2	.63	2-10	8.6
DNA	3	.68	3-15	10.3
Hi-Tech	3	.72	3-15	9.4

Factors related to technology acceptance

Tests of the hypothesized relationships between the characteristics of the respondents to their acceptance of the technologies are reported in Table 3. Statistically significant relationships were found for only three of the nine tests. As predicted, age was negatively associated with acceptance of alternative energy sources and high-technology, with younger farmers generally being more supportive of these technologies. Education was positively related to support for "hi-tech" innovations, but was not related to levels of support for alternative energy sources or DNA research. Income of the respondents was not related to support for the three technology scales.

Contrary to expectations, the three farm characteristics were largely unimportant to the farmers' attitudes about the three new technologies (Table 3). Total acres farmed and gross farm sales were positively related to acceptance of the "high-tech" items. Those on larger farms, whether measured by total acres or gross farm sales, were the most supportive of "hi-tech" innovations.

Summary and conclusions

This study raises some important questions about how farmers view new technology. Past conclusions from the adoption/diffusion literature about how personal and farm characteristics are related to support for new technologies are not confirmed in this study. Only five of the 18 posited relationships suggested by the adoption/diffusion literature were statistically significant. Four significant relationships were support for high technology by age, education, farm

Table 3. Relationships of Personal and Farm Characteristics To Farmers' Opinions About Innovative Technologies.

Characteristic	Technologies (scale scores): Alternative Energy Sources	DNA Research	High Technology
	mean scores		
PERSONAL			
Age	(N=1092)	(N=1067)	(N=1054)
Less than 35	9.0)	10.8	11.3)
35-54	8.6)	10.2	9.7))
55 and older	8.5)	10.5	8.7)
Education	(N=1094)	(N=1070)	(N=1054)
Less than 12	8.4	10.2	8.3))
12	8.6	10.3	9.1)))
13-15	8.6	10.5	10.1))
16 or more	8.7	10.8	11.1)
Income	(N=798)	(N=786)	(N=760)
Less than $20,000	8.6	10.3	9.5
$20,000-$49,999	8.5	10.3	9.3
$50,000 or more	8.5	10.6	9.9
FARM			
Acres owned	(N=1086)	(N=1060)	(N=1040)
Less than 115	8.6	10.3	9.3
115-196	8.4	10.4	9.2
197-319	8.5	10.3	9.2
320 or more	8.6	10.4	9.7
Total acres farmed	(N=1263)	(N=1234)	(N=1214)
Less than 285	8.5	10.3	8.9)))
285-438	8.6	10.3	9.6))
439-660	8.8	10.8	10.0)
660 or more	8.6	10.2	10.3)
Gross farm sales	(N=1237)	(N=1210)	(N=1190)
Less than $40,000	8.5	10.3	8.6))
$40,000-$99,999	8.7	10.4	9.3))
$100,000 or more	8.5	10.4	10.4)

) denotes statistically significant differences between the designated subgroups at or beyond .05 level.

size, and gross sales.

It is impressive to reflect on the widespread support that alternative energy production from feed grains and oils and from livestock wastes received across all types of farm operations. While no statistically significant relationships were found on the DNA scale, it is noteworthy that 66 percent supported DNA research on animals, 63 percent supported agronomic DNA research, but only 29 percent approved of DNA research on humans.

The amount of opposition to computer assisted machinery, confinement livestock facilities, and personal computers was not expected. Even though these technologies are relatively widely used, a substantial proportion of farmers opposes them. For example, 41 percent expressed opposition to robotics, which was defined as computer-assisted machinery for on-farm use. Given the increased use of computer technologies on planters, sprayers, and other machinery to monitor things like belt speeds and seed and chemical applications, this level of opposition was unexpected. Likewise, while 50 percent of Iowa farmers supported confinement livestock facilities, 30 percent indicated objections to this technology. Given the fact that Iowa produces about one-third of the nation's pork, much of it in confinement facilities, and that livestock facilities are a common feature of the Iowa landscape, it was surprising that such a large proportion of Iowa farmers are opposed to their use. Similarly, we were struck by the finding that 21 percent of Iowa farmers indicated opposition to personal computers for farm families.

It should not be assumed that those who oppose the technologies included in the survey are small hobby farmers, back to nature enthusiasts, or Luddites who are intent upon destroying all types of modern technology. The small differences between the mean scores for the three technology scales suggest they are unrelated to personal and farm characteristics. Farmers on large operations were just as likely to oppose these technologies as small farmers.

This analysis suggests the need for additional study of the factors that shape farmers' opinions about new technologies. Given the generally low relationships obtained in this analysis for personal and farm-firm characteristics, it seems that public acceptance and rejection of these technologies is dependent upon yet unidentified factors. Although data were not available in this study, we suspect that moral and ethical factors may loom large in the rejection of some of the third-wave technologies. Moral considerations, which have been sorely neglected in the adoption literature, could be pivotal both to how farmers react to the newer technologies and to the scientific endeavors that create them.

Given the modest amount of support for several established technologies, such as confinement livestock facilities, it appears there is at least a glimmer of interest among farmers in alternative agricultural systems. Unfortunately, data were not available to determine why 30 percent of Iowa's farmers opposed livestock confinement facilities or why 41 percent opposed computer-assisted farm machinery. We suspect, however, that moral, ethical, and perhaps environmental factors offer important explanations. Some justification for the need to consider moral and ethical factors is found among the DNA research items. Respondents were making rather large distinctions between DNA research on livestock and plants versus humans. As farmers feel the economic grip of the farm crisis and witness further changes in the structure of agriculture, it may be that they are growing increasingly wary of new technology.

An unexpected result of the farm crisis may be a heightened awareness of the role of technology in the changing structure of agriculture. As farmers tie their financial troubles to the increased capitalization in modern technology, they may become more receptive to alternative low-cost, low-input ecologically beneficial systems.

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Cancer risks cited

Kansas farmers exposed for over 20 days a year to herbicides containing phenoxyacetic acid had a six-fold increase in some cancers of the lymph system compared to non-farmers, according to a recent study by Dr. Shelia Hoar of the National Cancer Institute. Farmers who often mixed or spread the herbicide showed an eight-fold increase in the cancers. Researchers report that 2,4-D, one of the herbicides studied, is the most widely used weedkiller in Kansas. The study, which will be published in the *Journal of the American Medical Association*, looked at Kansas cancer cases reported between 1976 and 1982.

Integrated fish farming: An international effort

Gerald Schroeder

Abstract. *In much of the developing world, the high cost of purchased feeds makes meat and milk too expensive to be consumed by the producers' own families. A fish pond integrated with livestock or crop production provides an important source of animal protein for home consumption or sale. This protein involves almost no cash costs, since the needed nutrients and energy are supplied by crop residues, green manure, livestock manure and sunlight. Conversion of manure into animal flesh is possible because the anoxic sediments support a microbial flora similar to that of the rumen. Although integrated fish farming has been practiced for thousands of years in China, it has not yet been successfully adapted to all regions for which it potentially is applicable. A program in Wuxi, China brings together students and scientists from all over the world who are working towards that goal.*

The scarcity of animal products in the developing world

Half the children of preschool age in Southeast Asia suffer from protein-energy malnutrition (PEM) even though in many areas where PEM seems to be endemic, enough food is produced to allow the country to be a net exporter. In part this imbalance occurs because food is not well distributed within the country and because the poor are unable to pay for more than the barest subsistence diet. The adage about the shoemaker's children going barefoot applies to much of the Third World. Even though more than four-fifths of the population of the developing world is rural, neither the farming community nor the urban population receives an adequate and affordable diet.

Where animals must be raised with purchased feeds, production is so expensive that peasant families usually cannot afford to eat animal products. Rather, these must be sold to buy feeds for the next year's production cycle. Of course, this assumes that there will be feed to buy, an assumption that can be overly optimistic. Purchased feeds require a combination of ingredients such as soybean meal, fish meal, and wheat. Even if a developing country produces one of these, it probably will not have the others. Therefore it must import them, which reduces its limited reserves of foreign currency. Using reserves for this purpose is sufficiently discouraged in most developing countries and animal feeds are in short supply. Consequently, animal products, both meat and milk, likewise are scarce.

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Fish as "ruminants"

Some animals, of course, do not require refined feeds for their main diet. Ruminants grow quite well, producing both meat and milk, on diets that are very high in crude fiber. Fiber is processed into the needed nutrients by the microbial community of their rumen. If the diet is low in nitrogen, this can be supplied in a non-protein form, such as urea or ammonium sulfate. The nutrients produced this way are in the form of microbial cells plus an abundant flow of intermediate molecules (largely volatile fatty acids) that are produced during anoxic fermentation. These are rapidly absorbed across the rumen wall and serve as precursors of lactose.

Fish also have a rumen, in a sense. Actually, the pond they live in has one. There are many species of fish that thrive on the same types of microbes and microbial products as are found in the rumen. These fish may have developed this ability because the fish pond acts like a sunlit rumen. Because it is sunlit, minerals and carbon dioxide get converted into algae and life-supporting oxygen. The algae not harvested directly by filter feeding zooplankton and fish settle to the pond sediment. Cellulose digestion is highest in the anoxic environment near the sediment-water interface (typically, sediments are anoxic at less than 1 mm depth). Here, in the "rumen" of the pond, anoxic fermentation converts crude fiber and the recalcitrant walls of algal cells into digestible microbial slime. Figure 1 shows that after only 5 days in a fish pond receiving chicken manure, a cotton cloth (> 97% cellulose, < 1% protein) was intensely digested at the water-sediment interface. (The bottom was flocculant and not clearly defined.) This pond was fresh water, but the pattern of decay is similar for salt water.

Some fish thrive on these microbial slimes, especially benthic feeders such as the common and bigbelly carps (*Cyprinis carpio*), the crucian carp (*Carassius cuvieri*), and several tilapia hybrids (*nilotica* x *aurea; nilotica* x *hornorum; mossambica* x *hornorum*). However, the recycling of agricultural residues via the fish pond is not limited to traditional benthic feeders. Although it is usually assumed that grass carp (GC, *Ctenopharyngodon idella*) require a supply of grass for rapid growth, Zhou, Schroeder and She (work in progress) have found that straw, cow manure or chicken manure are equally good as substrates for supporting GC growth. However, stocking density must be adjusted, since grass is consumed directly, while manures are consumed indirectly and require microbial processing prior to assimilation. In polycultures with filter and benthic feeding fish species and total fish densities of 10,000 to 20,000 fish/ha, GC stocked at 500 to 1,000/ha grow 3 to 5 g/day

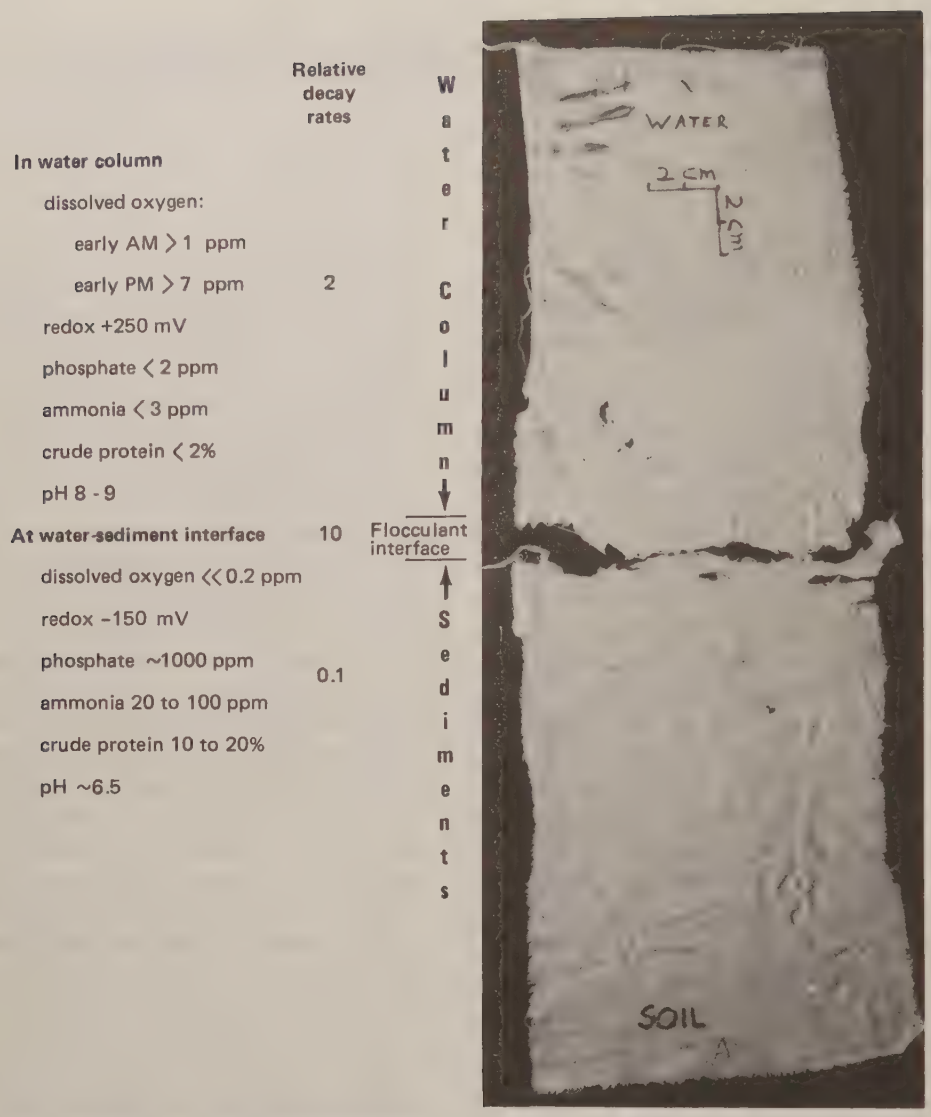

Figure 1. Cotton cloth after being suspended for 5 days in a freshwater fish pond receiving chicken manure. Water temperature was 27 to 31 C; crude protein 6.25 x Kjeldahl N of cloth plus slime on cloth after 5 days.

with straw, manure, or fresh grass as the pond input. With fresh grass, the GC stocking density can be increased to 5,000/ha with no decrease in growth rate. The unassimilated portions of grass in the GC feces provide the manure input to the pond for other fish species. Stable isotope data (Schroeder, 1983) indicate that in manure-loaded ponds, GC growth is based on manure and algae.

The microbial processes of the pond are the basis for integrating fish farming with animal husbandry or with vegetable or cereal crop farming. Most forms of organic matter added to the pond settle to the bottom and undergo microbial processing and upgrading. The process is very effective. In fact, as much as 10 tons of fish/ha/year can be produced in a properly managed fish pond that gets no feeds and whose only organic input is an adequate supply of agricultural residues, such as animal manures or straw (Moav et al., 1977). If a farmer has a pig, about 40 chickens or ducks, or a cow, he can maintain a backyard pond 20 m by 20 m, 0.5 to 1 m deep. Selectively harvested once or twice a month, this 400 m^2 pond will meet the protein requirements of 2 adults and 6 children (1.0 to 1.5 kg of fish/day, containing 150 to 300 g protein). This permits him to change from a subsistence peasant whose production is high in starch but poor in protein and lipids, to a farmer who not only meets the nutritional needs of his family but also produces a commercial surplus that helps meet the needs of his community.

Integrated fish farming is highly efficient. With manure as the source of organic matter, a surprisingly low input is required. The minimum starting rate of manure organic matter (OM) is 40 kg/ha/day, which then is increased with fish growth to maintain an input equal to 2 to 3% of the fish biomass. The maximum that a pond can process is approximately 150 kg/ha/day. When the fish biomass exceeds 5000 kg/ha, the manure input rate remains constant. The same feeding rate is needed to get the same fish yield using a standard 25% protein feed containing 15% fish meal. Clearly the "sunlit rumen" we call a fish pond is very efficient in converting crude fiber into fish flesh. For planning an integrated farm, the following are rough but useful guides to the amount of manure produced by various animals (in kg OM/100 kg live weight): cattle and sheep: 0.5 to 1; pigs: 1 to 1.5; chickens and ducks: 1 to 2.5.

The general flow of organic matter, here characterized as organic carbon, within a well managed fish pond is shown in Figure 2. The relative amounts of growth of fish attributed respectively to algal and manure food webs was determined by comparing carbon isotope ratios of fish flesh and gut content to those of microscopically identified gut contents (Schroeder, 1983; Spataru et al., 1983).

An example of the effectiveness of integrated fish farming

Integrated fish farming can be economically attractive as well as highly efficient, as illustrated by an example based on data from a survey I made of farms in central Thailand. The survey and the ensuing project on integrated duck and fish farming are discussed in Plavnik et al. (1983). The figures given are representative of yields on well managed farms. Yields under poorer management can be expected to be lower. The prices quoted are for 1979.

In this example, a farmer originally uses all of his own and his sons' labor for his 1.5 ha of rice paddy, while an

elderly family member raises 200 ducks on a nearby reservoir for eggs. Rice offers security against a bad season, since it can be dried and stored. At a price of 2.5 baht/kg, rice provides an annual revenue of 30,000 baht. The ducks lay approximately 130 eggs/day (300 active days/year/duck). At 1.5 baht/egg, gross revenue is approximately 60,000 baht/year. However there is little profit, since most of the revenue goes for the ducks' feed, which consists of one part fish meal concentrate and 5 parts paddy rice.

Two fish ponds are then dug, each 0.1 ha (1000 m^2) by 1 m deep. This takes up less than 15% of the paddy area, leaving 85% for traditional rice culture, an important source of security for the family's food supply. Tractor costs for the work are 10,000 baht. The farmer builds one duck house over each pond to provide shade and layer beds. No change is made in the ducks' diet. The feeding platform is located directly over the pond, and the screen floor of the duck house allows all droppings to enter the pond. The ducks are confined by a 30 cm high fence surrounding the pond.

Each group of 100 ducks produces about 5 kg dry organic matter per day in feces, which support a rich growth of algae and microbial nutrients. Often primary productivity (carbon fixed in algal growth) reaches a rate of 10 g/m^2/day. Of this 5 g is consumed in algal respiration, and 0.5 to 1 g is harvested pelagicly by filter feeding fish and zooplankton. The remaining 4 to 5 g carbon precipitates to the sediments where, along with the duck feces, it is processed by microbes in the "rumen" of the pond.

The annual yield of fish (tilapia, bottom feeding carps and filter feeding silver carps) reaches 1 ton live weight per pond. Selective harvesting is possible once or twice per month, depending upon the size of the fish used by the family. At 15 baht/kg fish, annual revenue is 30,000 baht. Except for the cost of fish fingerlings, this is almost entirely profit. Labor is incidental, amounting to only a tiny fraction of that required in the paddy, and less than 15% of the paddy area has to be given over to this system. The yield of eggs will likely rise, since the ducks thrive on the algae-rich waters. Moreover, when rice and fish are alternated in several paddy-ponds, yields of both will probably increase. The "rain-out" of nutrient-rich algae and feces into the pond sediment provides an excellent fertilizer base for the rice. Accumulated catabolites that potentially are detrimental to fish growth will be removed or neutralized through incorporation of nutrients in the rice and oxidation of sediments when the paddy is drained prior to being filled and stocked with fish.

International efforts to improve integrated fish farming

Integrated fish farming works best in tropical and subtropical climates. In these warm regions, the growing season often exceeds 250 days/year. The warm water and sediments favor high metabolic rates for the microbes active in processing the crude fiber of the added agricultural residues. However, the methods cannot automatically be transferred among locations. First, an adequate supply of manure is not always available for aquaculture, since it also is needed as a fertilizer for field crops. Also, the complex phenomena govern-

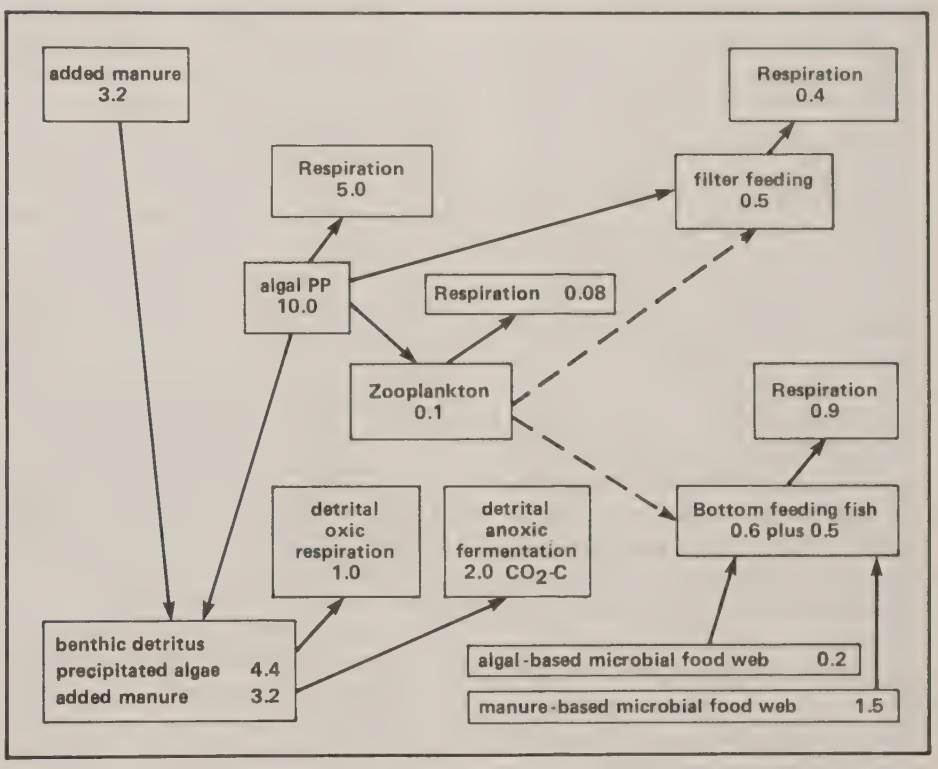

Figure 2. Flow of organic carbon in food webs of an integrated fish pond.[1,2]

[1]Numbers in blocks are g C/m^2/day. PP = primary productivity.

[2]Pond Conditions:

fish density:	10,000 to 20,000/ha
fish growth (live weight):	30 kg/ha/day
species:	silver carp (pelagic filter feeder), 10% tilapia (benthic deposit feeder), 65% common carp (benthic particulate feeder), 25%
total fish biomass:	5 t/ha
water temperature:	25 to 32 C
hardness:	> 100 ppm as $CaCO_3$
pH:	water 7.5 to 9.5; sediment 6.5
dissolved oxygen:	
water:	> 1 ppm at sunrise > 8 ppm late afternoon
sediments:	anoxic

ing the effectiveness of an integrated farm must be understood. This understanding must be translated into methods appropriate to local conditions. While locally available fish species are often adequate, the proper polyculture of filter and bottom feeding fish must be established to maintain the ecological balance in what might become a hypereutrophic system with severe cycles in the level of oxygen dissolved in the pond water. If the oxygen concentration is near zero for only a half a day, the entire fish crop can be killed. Only when these factors have been dealt with can a farmer in Mexico, say, be confident about taking the risk of investing in a system that has worked in Thailand. When it has been suitably adapted, integrated fish farming has the potential to turn subsistence peasants in many parts of the world into productive farmers.

This is why work on integrated farming has become an international undertaking. China, under the sponsorship of the United Nations' Network of Aquaculture Centers in Asia (NACA), has established an Integrated Fish Farming Center at Wuxi, Jiansgu Province (two hours by train northwest of Shanghai). The IFFC was the first international research and training center of any type to be established in China after the cultural revolution's curtailment of contacts with foreigners. A steady stream of students, scientists, extension workers and technicians come to Wuxi from around the world to improve the understanding of the processes occurring in an integrated fish pond. During the summer growing season, as many as 40 students of fish farming (technicians to managers) from countries as far away as Chile and Mexico are present. Instruction is either in English or in Chinese translated into English. Regardless of political persuasion, the students live and eat together on the IFFC Campus.

China has practiced integrated fish farming for three thousand years. Even though it has flourished in several regions of the country, attempts to adapt this approach to new locations have not always been successful. Many balances must be established: between the rate of production of natural foods and their harvest by target fish; between production of oxygen by algae and its respiration by the entire biological community; and between release of potentially toxic catabolites and their neutralization, assimilation or adsorption by the microbes and minerals of the pond. Even some mundane questions remain unanswered: the minimum amount of fertilizer to attain a given fish yield; whether grass should be fermented before being added to the pond; and whether manures must be added daily rather than just once per week.

To answer these questions about an old and traditional system, the IFFC uses techniques as modern as tritium-labelled thymidine to quantify bacterial metabolism, and stable isotope ratios for $^{in\ situ}$ tracing of food webs. Scientists discuss the newest results in accents as diverse as Australian and Hebrew. But all have a single goal: to develop a technology that will insure more and better food for the portion of our planet within 25 degrees of the equator where so many children now go hungry.

Acknowledgment. The author wishes to thank Dr. William Lockeretz for his substantial contribution to this article.

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Assessment identifies organic research

An assessment of farming systems projects funded in Fiscal 1982 by state and federal sources indicated 4.2% of the money went for research with "special organic relevance." This research dealt primarily with crop rotations, use of manure and other organic materials, nitrogen fixation, allelopathy, and biological control of weeds, insects, and other pests.

The assessment report, *Conventional and Organic-Related Farming Systems Research: An Assessment of USDA and State Research Projects*, was published as Special Report 91 by the Agricultural Experiment Station at Iowa State University. It was prepared by F. W. Schaller and H. E. Thompson of ISU's Department of Agronomy and C. M. Smith of USDA's Cooperative State Research Service.

The report showed that state and federal outlays for farming systems research totaled $574.7 million in the year beginning Oct. 1, 1982. Support for projects with special organic relevance totaled $24.4 million. The largest outlays in the organic-relevance category went for soil fertility ($9.5 million) and pest control ($6.6 million) studies. The soil fertility research included $2.2 million for work on sewage sludge utilization.

The assessment, based on information provided to USDA's Current Research Information System (CRIS), identified 6,413 farming systems research projects. "Projects related to farming systems were considered neutral unless they were mainly considered to be of little or no interest to organic producers, such as projects concerned with synthesized fertilizers, pesticides, growth regulators, and feed additives," the report states. "Projects classed as having special organic relevance involved research considered especially applicable to organic systems..."

The authors defined farming systems projects as those designed and conducted to investigate areas and ideas that would aid and improve on-farm production of crops and livestock. They reported that the organic relevance of a project was a judgment call based mainly on the definition used in USDA's 1980 organic farming report.

Soil management guide is published

The second edition of a guide to help farmers make soil management decisions based on ecological principles has been published. The 125-page book by Grace Gershuny and Joseph Smillie includes sections on understanding the soil ecosystem, observing and evaluating soil, soil management practices, and the organic marketplace. *The Soul of Soil: A Guide to Ecological Soil Management* is available for $7.50 postpaid from BAIA Services, RFD 3, Box 84, St. Johnsbury, VT 05819.

New small-scale machinery guide out

A buyer's guide based on a worldwide survey of 6,000 manufacturers of small-scale farm equipment has been published. The information is divided into 13 chapters dealing specifically with various phases of small-scale farming. The 264-page indexed and illustrated guide also includes names and addresses of suppliers of more than 3,000 items.

Tools for Agriculture is the third edition of a standard reference work on small-scale farming. It is available for $30.50 postpaid from Intermediate Technology Group, Publications Office, Box 337, Croton-on-Hudson, NY 10520.

Resource report covers 146 countries

A resource base assessment prepared jointly by the World Resources Institute and the International Institute for Environment and Development is now available. *World Resources 1986,* issued as the inaugural volume of an annual WRI/IIED series, includes nearly 200 pages of resource reviews dealing with everything from food and agriculture to atmosphere and climate.

The 353-page global report, which includes resource data tables for 146 countries, is published at $16.95 by Basic Books and sold through bookstores.

California farmland report available

A new American Farmland Trust report examines urban growth, salinity, soil erosion, and water supply problems of California agriculture. It concludes that depletion of the state's agricultural resources threatens the future productivity of its leading industry.

The 103-page report acknowledges the shrinking role of federal involvement in alleviating resource conservation problems and includes a discussion of 20 state and local government options. Copies of *Eroding Choices, Emerging Issues: The Condition of California's Agricultural Land Resources* are available for $7.50 postpaid from American Farmland Trust, 512 Second Street, San Francisco, CA 94107.

Farmland preservation directory published

A directory of 160 farmland-related organizations active in the Northeast has been published by the Natural Resources Defense Council. It lists organizations in farmland and open space conservancy, land use planning, sustainable agriculture, land trust development, farm management, and agricultural finance. Copies of *Farmland Preservation--Northeast United States* are $12 postpaid from NRDC at 122 East 42nd Street, New York, NY 10168.

Michigan pesticide report is released

A report prepared for a state environmental council recommends a long list of steps aimed at improved pesticide management in Michigan. The 176-page document was developed with input from five public hearings and assistance from a pesticide advisory committee. It recommends tightening state rules and regulations dealing with the full range of pesticide uses. Copies of *A Strategy for Improved Pest Management in Michigan* are available from the Michigan Department of Agriculture, P.O. Box 30017, Lansing, MI 48909.

Monograph discusses organic fertilizer

A new publication that emphasizes utilization of organic residues as fertilizer is available from the Woods End Agricultural Institute. The 167-page monograph discusses relationships between residues, nutrients, soil, and plants. Copies of *Organic and Inorganic Fertilizers* are available for $12.50 postpaid from Woods End Agricultural Institute, RD 1, Box 4050, Mt. Vernon, ME 04352.

NRC publishes groundwater pollution report

The nature and scope of groundwater contamination by pesticides in California, New York, Wisconsin, and Florida are reported and analyzed in a

124-page report prepared for the Board on Agriculture of the National Research Council. The four state case studies are supplemented by short chapters on Environmental Protection Agency monitoring efforts and on information obtained in interviews with representatives of four chemical companies and the National Agricultural Chemicals Association. Copies of *Pesticides and Groundwater Quality: Issues and Problems in Four States* are available for $12.50 postpaid from National Academy Press, 2101 Constitution Ave., N.W., Washington, DC 20418.

Worldwatch global assessment published

The 1986 Worldwatch assessment of the effect of a deteriorating global resource base on the international economic system has been published. The 263-page report, the third in a series from the Worldwatch Institute, emphasizes economic, social, and political consequences of ecological deterioration.

Copies of *State of the World 1986* can be obtained by sending $8.95 to the Worldwatch Institute, 1776 Massachusetts Ave., N.W., Washington, DC 20036.

OTA releases report on the Sahel

Successful technologies to solve drought- and famine-related farm problems in the Sahel region of Africa should clearly focus on low cost, low risk, sustainable technologies, according to a recent study from the Congressional Office of Technology Assessment (OTA). Promising technologies are also likely to be site-specific, involve farmers, be based on localized research, and take into account the needs of low-resource producers, including women, who are in the majority among Sahelian producers. The report said assistance must keep projects simple and more geared to user's needs. The study was requested by Congress to guide assessment of efforts to help solve famine problems in the Sahel. The report, *Continuing the Commitment: Agricultural Development in the Sahel*, is available for $8.50 from the U.S. Gov't. Printing Office, Washington, DC 20402 (stock number 052-003-01043-7).

New quarterly available

The American Agricultural Economics Association has begun publishing a new quarterly called *Choices*. It is edited "for people who want to be informed about food, farm and resource issues -- and the policies that affect them." For subscription information write: *Choices*, c/o Dunnington Communication, 1250 Eye Street, N.W., Suite 300, Washington, DC 20005.

Japanese group produces new film

The MOA Foundation, a Japanese organization involved in alternative agriculture is the U.S. distributor of a new film called *"Living Soil."* Produced in Japan, the film discusses the concepts and practices of nature farming on MOA farms in Izu-Ohito, Japan. The film is on one-half inch videocassettes and can be purchased for $35 or rented for $25 a month. Write: MOA Foundation, 535 Madison Ave., New York, NY 10022.

Costs and risks lead to agrichemical shakeout

Dropping sales, research costs, and loss of patent protections are causing a shakeout in the agrichemical industry, according to reports in the *Wall Street Journal* and the *Des Moines Register*. In July, Union Carbide put its farm-chemical unit up for sale; Shell Oil Company is reported to be working out a sale of its farm-chemical operation to Du Pont Company; and Monsanto Company has dropped its research into plant growth regulators.

Overall, U.S. herbicide sales have fallen by 13% from 1984's $2.98 billion, reports the National Agriculture Chemicals Association (NACA). That slump is the combined result of a pressured farm economy and government incentives for taking land out of production, say analysts.

Simultaneously, research costs for new farm chemicals are escalating, with NACA estimating that it takes $10 million to develop a new product, up from $6 million a decade ago. Shell Oil had estimated that it would need to quadruple sales from its 1985 level to support its research program, for example. Pest resistance to chemicals is one reason for the costs, since new products must be developed from completely different compounds than those now on the market.

Impending losses of patent protection on pesticides such as Shell's Bladex herbicide will allow competitors to market identical compounds, the *Register* says. At the same time, growing research on the health and environmental effects of some farm chemicals is leading to stronger testing requirements for farm chemicals as well as to regulation about their use. Dr. Charles Benbrook of the National Academy of Sciences has projected severe restrictions on up to half a dozen major farm chemical products in the next five years.

Benbrook also expects to see a new generation of herbicides that will be environmentally safer and applied at much smaller rates. Six such new-class chemicals were put on the market by Du Pont in 1986. But the *Des Moines Register* raises a concern about how many companies will be able to afford developing such products. The effects of concentration in the farm-chemical industry could be higher costs for farmers, the *Register* speculates.

Toward a More Sustainable Agriculture. 1986. By Raymond P. Poincelot. 241 pp. AVI Publishing Company, Inc., **Westport,** CT 06881. ISBN 0-87055-518-9. $28.50.

The capacity of U.S. Agriculture to produce food and fiber today is indeed impressive. The actual on-farm production system employs some 3.4 million workers and involves some 2.4 million farms. Today, one hour of farm labor produces 14 times what it did during 1919-1921. A staggering statistic is that one farmworker currently produces food and fiber for 78 people. Yet, despite this production capacity many of our farmers are going bankrupt because of high energy costs and inputs, low prices received for basic agronomic crops, inefficient methods of production, over-capitalization and a high level of indebtedness. Consequently, many farmers must focus strictly on production of intensive row crops for short-term economic gain while essential conservation practices are largely neglected. Moreover, there is increasing evidence that excessive soil erosion associated with conventional tillage systems is causing a significant loss of soil productivity.

This scenario and the current state of U.S. Agriculture is effectively described in this book by Dr. Raymond P. Poincelot. It has become a matter of great concern that production agriculture without the necessary conservation measures is threatening the resource base of U.S. agriculture. Many will agree with Dr. Poincelot that at their present rate of use, and environmental misuse, the energy, soil, and water resources cannot sustain U S. agriculture over the long-term. The main threat to our agricultural resource base stems from the depletion of finite resources and their contamination by sediment from soil erosion, excessive use of chemical fertilizers, pesticides, and salinity which can render soil and water resources unfit for use.

The purpose of this book according to its author is to create a greater public awareness and support for changes in the U.S. agricultural production system that would move it toward one that is more sustainable, stable, resource conserving, and hopefully more profitable in the long-term. It is most difficult to write a book on this subject with the intent of reaching such a wide range of agricultural and non-agricultural communities. However, Dr. Poincelot has done precisely that, and he has done so very effectively. The book will be of interest to educators, extension workers, farmers, research workers, undergraduate and graduate students, environmentalists, ecologists, policymakers, and politicians. As the author points out, the format of the book is variable and covers a wide range of subject matter that could contribute to a more sustainable agricultural system. This approach was necessary to reach such a diverse, but essential, audience. Thus, some will at times find the material to be rather simple, while others will feel it is highly technical. Nevertheless, most readers will find the book to be well organized and relatively easy to read and comprehend. It is also appropriately illustrated with useful graphs, tables, and figures.

The book begins with a chapter on "Our Threatened Agricultural Resources" wherein the author briefly outlines the reasons for our current agricultural dilemma including energy costs, groundwater pollution, soil erosion, acid rain, salinization, and the associated loss of soil productivity. He also urges the establishment of a national (and regional) clearinghouse that would focus on agricultural sustainability as a national goal. Such infrastructure would receive, assess, coordinate, and distribute information on alternative, sustainable, regenerative, or low-input farming to agricultural research agencies, land-grant universities, extension agents, and farmers.

The remaining chapters deal with subject areas and related technologies and ideas that might have considerable potential in helping farmers to reduce their input costs. Chapter 2 deals with "Organic Farming" in which the author does an excellent job of reviewing the various aspects and issues that have emerged since the USDA study team published its "Report and Recommendations on Organic Farming" in 1980. He concludes that there is much in common between organic agriculture and sustainable agriculture. One major difference he cites is in the use of agricultural chemicals. Sustainable agriculturists appear to advocate the judicious use of chemicals, i.e. fertilizers and pesticides, for supplementation, while organic agriculturists think in terms of their substitution or non use. This, however, is rather a fine distinction and one that could be debated depending on various points of view. Future prospects of organic/sustainable/alternative agriculture and research needs are thoroughly assessed by the author.

"Crop Energy Conservation" is the subject of Chapter 3 which covers the energetics of crop production and addresses the possible reduction in fertilizer usage, increased use of organic wastes and legumes, and implementation of conservation tillage systems to lower the energy requirement of current production systems. "Greenhouse Energy Conservation" is covered in Chapter 4 which will be of considerable interest to some readers.

In Chapter 5 on "Animal Husbandry Energy Conservation" he points out that 90% of the energy used in U.S. Agriculture goes to crop production and 10% for livestock operations.

However, when one considers the extent to which basic commodity crops are used for animal feeds, livestock then becomes the most energy demanding product of U.S. Agriculture. Ways and means of reducing this energy input are discussed. In Chapter 6 on "Postproduction Energy Conservation" he cites that crop and livestock production account for only 18% of the energy used in the food system, while the remaining 82% is consumed in food processing, packaging, marketing and distribution, and transportation. Again, suggestions for reducing this energy input are presented.

"Sustaining Soil Resources" is the subject of Chapter 7 in which the current issue of the effect of soil erosion on long-term agricultural productivity is discussed, along with best management practices to control wind and water erosion on U.S. farmland. Not surprisingly, these conservation practices focus on the proper use of crop residues, animal manures, and municipal organic wastes, i.e. sewage sludge and septage, to control soil erosion.

"Sustaining Water Resources" is covered in Chapter 8 wherein the author cites the high energy costs associated with irrigation in U.S. Agriculture and accurately describes the current transition from irrigation back to a dryland/fallow cropping system that is underway in the Southern Great Plains and elsewhere. He also describes some new irrigation practices that could greatly increase the efficient use of water such as trickle or drip irrigation. The use of brackish water on salt-tolerant crops at certain times during the growing season may also be a viable option for conserving low-saline water resources.

"Sustaining the Environment" is the subject of Chapter 9 in which the author discusses agriculture's impact on the environment. Sediment is indeed the largest single agricultural pollutant; however agriculture's possible contribution to the pollution of groundwater by pesticides and nitrate is an increasingly important environmental issue. Integrated pest management (IPM) practices, if successful, can minimize the pollution of soil and water resources by pesticides.

The concluding chapter is entitled "Future Technology" which covers such topics as solar technology and use in crop drying, and space and water heating. Also discussed are windpower and hydroelectric and geothermal power. Aspects of biotechnology and their possible future contribution to a more sustainable agriculture are addressed.

Each chapter contains appropriate references that will provide readers with more detailed information should they desire it. The author strongly suggests that the cooperative extension service should give high priority to communicating the results of alternative or sustainable agricultural research to farmers and the public. The book should be widely acquired by many who wish to be better informed as to the current plight of U.S. Agriculture and to possible options and technologies that might be appropriate in shifting it toward a more sustainable basis. -- *James F. Parr, National Program Leader, Dryland Agriculture and Soil Fertility, USDA-ARS and Coordinator, Dryland Agriculture Project, USDA-ARS/USAID, Beltsville, MD.*

New Directions for Agriculture and Agricultural Research--Neglected Dimensions and Emerging Alternatives. 1986. Edited by Kenneth A. Dahlberg. 436 pp. Rowman & Allanheld, Publishers, 81 Adams Drive, Totowa, NJ 07512.

Editor Dahlberg has put together a volume whose time is now! Resulting from a project funded by the Ethics and Values in Science and Technology Program of the National Science Foundation and the National Endowment for the Humanities, this book is "must" reading for the directors and leaders of the agricultural research establishment, the concerned scientific community, those interested in the application of sciences to agriculture, and others who care about rural life.

And especially for the readers of the Journal of Alternative Agriculture, this collection of essays offers material we will be able to use, to quote, to share with others, and from which we ma learn!

Some excerpts which were particu larly attractive to this reviewer follow but they fall far short of revealing th wholesomeness of this volume. The are merely a sample of its flavor an aroma. Other readers with backgroun different from that of the present re viewer would find other segments es pecially appealing and thought provoking.

William H. Aiken opens the doo with: "There is no question that th American agricultural research systen has produced some wonderous re sults.... But on the other hand; the ac tivity created by the agricultura research system, just like any other sus tained, cooperative human activity, ha had some negative effects on people."

And in her excellent chapter, Jea Lipman-Blumen writes, "Control ove resources lies at the very heart of al power relationships - between nations races, socioeconomic and ethni groups, generations, and individuals." And later she goes on: "Reconcep tualizing and restructuring power re lationships will inevitably draw in thei wake additional choices. ...this wrench ing task will force us to review ou entire repertoire of values." "...hov shall we develop leaders who can han dle complex, paradoxical decision laced with moral imperatives?"

"The major task of agricultural re search," writes Charles F. Cooper "must be to find ways to increase th resilience of the agricultural systen and thereby assure its sustainability i a world of increasing population an demands for resources." Earlier, h pointed to the "ethical dilemma fo American agricultural research: are w justified in continuing to emphasiz high production, with its attendant en vironmental problems; when that pro duction may inhibit rural developmen in the importing countries?"

In their analysis of historical force that have shaped world agriculture Alain de Janvry and E. Phillip LeVee state: "We expect that future debate over food policy will not be in term of whether to preserve the family farm but, rather, how to reconcile the con

flicting interests of consumers, taxpayers, exporters, and farmers." ..."and needs of the present generation relative to future generations..." And writing about Third World countries..." to question the social control over the labor process and over the surplus generated by agriculture."

In Part III of the book, on the national setting, David B. Danbom points out that "Their relationship with market-oriented, productivity-conscious, commodity-based farmers had other effects on the researchers as well. It narrowed their focus and their interest, leading them unconsciously to identify the problems of agriculture with particular production problems of relatively small groups of commercial farmers."

Focusing on the context and implications of the National Agricultural Research, Extension, and Teaching Act of 1977, Dale L. Stansbury writes: "The single issue before us is not structure, priority setting, or focus of research; it is control. Each interest group wants to control ostensibly because it wants to do good." ...."For agricultural research to meet the challenges of the future, it must remain flexible, responsive, and relevant."

Among authors of Part IV, assessing neglected dimensions, William D. Heffernan writes: "In the 1930s, there had been an attempt by social scientists in the Bureau of Agricultural Economics of USDA to ask questions about social aspects of agriculture. The negative social consequences highlighted by these researchers were not appreciated by some influential politicians, and the Bureau was soon eliminated."

Patrick Madden supplements with "Thus, the more doctrinaire neoclassical economists have enthroned the vice of greed as a cardinal virtue." ..."The challenge before the agricultural research establishment is to organize itself and conduct its work in ways calculated to create science and technology that will lead to a "better" society, better according to ethics and values far beyond those embodied in current market prices."

And after giving a comprehensive and insightful analysis of energy and other natural resources used by agriculture and society, David and Susan Pimentel state: "A careful analysis of the various resource factors that influence agricultural production is needed to determine potential strategies for agricultural production recognizing the distribution of land and water resources and the location of the human population."

Of particular interest to readers of this Journal should be William Lockeretz' chapter on Alternative Agriculture. His evenhanded discussion of such matters as organic farming, energy, and localized food production, is revealing, as is his overview of the term, "alternative agriculture."

Frederick H. Buttel identifies some emergent issues as follows: "...the pivotal choices to be made about the role of the land-grant universities will result in unprecedented politicization." ..."Biotechnology can be devoted either to developing input-sparing production systems or input-intensive systems." ..."..the past decade was one of unparalled questioning of whether the socioeconomic costs of new technologies outweighed the benefits."

Chapter 15, by C. Dean Freudenberger should be of particular relevance to readers of this Journal. It's title is: "Value and Ethical Dimensions of Alternative Agricultural Approaches: In Quest of a Regenerative and Just Agriculture." His four central questions are:

1. Can social and agricultural systems be developed which stress the importance of responsible freedom in building a responsible society?

2. Can social and agricultural systems be developed which provide meaning in one's work and in one's relationships with society and natural environment?

3. Can social and agricultural systems be developed which recognize the primacy of life and its pattern of sustenance (in a full ecological sense)?

4. Can social and agricultural systems be developed which recognize the need to include the welfare (health, stability, integrity, beauty, harmony) of future generations of both human as well as non-human life forms?

And with regard to the future, John W. Bennett speaks of agricultural research as follows.... "While increase of output remains a major objective of most research programs, more effort is now exerted on determining how increases can be achieved without disruption of the social bases of production, and without abuse of resources." ...

In conclusion, Editor Dahlberg shows that "Four main themes emerge from the chapters: a) that the basic context of agriculture is changing in fundamental ways in terms of resource, socioeconomic, and technological trends (the magnitude of perceived change often being related to the degree of awareness one has of the other three themes); b) that there are a number of largely "invisible" externalities that need to be brought into our evaluations of the real costs and benefits of current agricultural production modes; c) that a wide range of alternative approaches and conceptions are emerging which need to be considered seriously and carefully by all concerned about the future of agriculture; and d) that the choices in and between conventional and alternative approaches to agriculture require us all to clarify our personal and societal goals and priorities and their underlying values."

These excerpts are inadequate to reflect the rich resource which may be found in this book. For readers of the American Journal of Alternative Agriculture, it may be the "core curriculum." -- *George H. Axinn, Professor, Department of Resource Development, Michigan State University.*

Soil Erosion and Conservation. 1985. S. A. El-Swaify, W. C. Moldenhauer, and Andrew Lo (eds.). 806 pp. Soil Conservation Society of America, 7515 Northeast Ankeny Road, Ankeny, IA 50021-9764. Cloth $35.00.

This book comprises the proceedings of the International Conference on Soil Erosion and Conservation, which was sponsored by the Soil Conservation Society of America and held in Honolulu in January of 1983. It was the third

international conference on soil conservation in recent years. A workshop on soil erosion assessment in 1978 at the Agricultural University of Ghent (Belgium) was hosted jointly by soil conservation groups in the United States and Europe. A conference held at the National College of Agricultural Engineering at Silsoe (England) in 1980 attracted international interest in soil conservation practices, problems, and prospects.

These conferences are most relevant and timely because some 4 to 7 million hectares of arable land throughout the world are being lost from the resource base each year due to severe soil erosion. In the United States, developing conservation and management practices to control soil erosion and to maintain and/or restore their productivity has become our highest agricultural research priority.

The book is divided into four major themes. Section I *Erosion Inventory* consists of some 20 papers on the magnitude and extent of soil erosion worldwide. Section II *Erosion Impacts* comprises 13 papers on the impact of erosion and sedimentation on soil productivity and the environment. The authors address changes in soil fertility and physical properties and report on experimental and modelling approaches to assess the impact of erosion on crop response, soil water characteristics, soil productivity, and economic relationships. Section III *Erosion Prediction and Control* is by far the largest and consists of 29 papers which deal with assessment of erosion-causing parameters and modelling and model adaptation for prediction and control of soil erosion. Section IV *Implementing Soil Conservation Programs* contains 11 papers which discuss various strategies for developing and implementing soil and water conservation programs in both developed and developing countries.

The overall thrust of the conference is to emphasize the seriousness of soil erosion worldwide and the need for soil scientists, engineers, and conservationists to develop appropriate technologies to sustain long-term soil productivity and transfer these technologies to others who can adopt or adapt them to their specific situations. It makes a strong appeal to foster global cooperation and networking in soil and water conservation research and information exchange.

Most of the papers deal with soil erosion and conservation practices, predictions, and control that are related to rainfall and irrigation. Only a few papers relate to wind erosion and that would appear to be an oversight by the organizing committee. In some semiarid regions, such as the Sudano-Sahelian zone of Africa, wind erosion is a much more serious problem than water erosion. Research is urgently needed to develop effective methods for measuring, predicting, and controlling erosion and sedimentation from wind.

The list of authors is impressive and those familiar with the subject matter will certainly recognize the names of many leading scientists and engineers. The book is an excellent contribution to the literature and should be widely acquired and consulted as a major reference. It provides a valuable international perspective on problems, practices, and policies relevant to soil erosion and conservation which, hopefully, will lead to a more sustainable agriculture in the years ahead. -- *James F. Parr,* National Program Leader, Dryland Agriculture and Soil Fertility, USDA-ARS, and Coordinator, Dryland Agriculture Project, USDA-ARS/USAID, Beltsville, MD.

World Food Population and Development. 1985. Edited by Gigi M. Berardi. 346 pp. Rowman and Allanheld Publishers, 81 Adams Drive, Totowa, NJ.

Gigi Berardi has pulled together a collection of readings suitable for use in an undergraduate-level course on world hunger issues. There are many such courses in American universities and they tend to attract the breed of politically liberal and ecologically concerned student which *Newsweek* likes to claim died out after the 1960s. Among such students, this book is likely to be popular because it raises the very issues they want raised, and reconfirms the notions that many of them probably started with. Therein lies my overall problem with this book. I do not believe it is sufficiently challenging to the students who are likely to use it. I also feel that the stated goal of the book, which is to encourage students to "ask the 'right' questions," is too modest in comparison with what it might have achieved.

The problem of world hunger has been a focus of both research and action among universities, governments, and public and private donor agencies for some 15 or 20 years. In that time there has been considerable progress in identifying the nature of the problem, its various causes, and the types of solutions which do and do not work, and why. The critical role of food pricing and agricultural policy has been recognized as a key to solving both food supply and distribution problems (Timmer, 1980); household dynamics and individual, culturally defined roles are becoming better understood as determinants of who receives the benefits of economic development (Van Esterik, 1984). It is also increasingly understood that the causes of any nation's hunger problem exist at many levels from the household to the nation's economic and political structure to the international marketplace, and that solutions must address all these levels. If a particular intervention, such as the development of high-yielding varieties of grain, does not automatically solve the hunger problem in a given country, it may not mean that the intervention itself is misguided, but rather that it breaks down only one of many barriers to optimal food consumption. The articles in this book do not, I feel, make this clear, nor do they reflect the progress which has been made in understanding ways to alleviate hunger and malnutrition in the less-developed world.

The book is laudable in its focus on the political and socioeconomic bases of the world hunger problem (for example, in the articles by George and Lappe' and Collins), and its emphasis on the fact that a global scarcity of food is not at fault (for example, in Eber

stadt's piece). The selection of articles clearly makes the point that the old neo Malthusian population bomb argument not only leads to morally repugnant conclusions ("lifeboat ethics"), but is also simply empirically wrong. This is a valuable point to make but I thought too much space was devoted to this outdated argument which is, in fact, rather simple to dispose of. More useful would be some specific suggestions on *how* to provide for the material security which is prerequisite to reducing population growth. For example, increasing market work opportunities for women in less developed countries both reduces fertility and increases a household's per capita income and resource base (Birdsall, 1980). Such concrete suggestions for policy change are rare in this book.

The book tries to represent diverse points of view although the editor's own opinions emerge clearly in the introduction, the editor's paragraphs preceding the readings, and in the selection and balance of articles. The most dramatic example of this is the inclusion of a fascinating and very persuasive article (one of the few reprinted uncut) detailing the dangers of having large corporations engage in bioengineering of seeds for crops. The possibility is presented of a few multinational corporations exercising full control over world food production, manipulating seeds so as to require purchase of the same corporations' pesticides and fertilizers. Such a capitalist conspiracy is certainly a possibility and a danger. However, bioengineering also raises the possibility of developing new strains of plants engineered to resist salt, drought, and particular diseases and pests, which would be of incalculable benefit to many developing nations. As with most powerful new technologies, bioengineering has incredible potential to do good as well as ill, and yet there is no discussion in the book of the positive aspects of this new technology.

In a similar vein, I felt that national economic policies which can affect food production and income distribution are given insufficient attention compared with more grassroots, community-level approaches. The latter are valuable, yet the serious issues of how to replicate small-scale projects so as to have an effect on a national scale is not raised in the book, and the potential of larger scale interventions is not discussed.

With a few notable exceptions (such as Pariser and Wallerstein's excellent article on fish protein concentrate), the selections in this book are analytically thin. Eight of the readings are brief news articles or op-ed pieces; the only article on the highly respected Oxfam organization is, incredibly, an excerpt from that organization's own public relations material. Many other articles are cut to only two or three pages, which does them an injustice in terms of their ability to present and argue a point. The clearest example is Hulse's article on food science, whose point is completely lost by cutting. And yet the technical level of, for example, Larson, Pierce and Dowdy's article on soil erosion suggests that the intended readership is assumed to be capable of reading some rather difficult material.

I would question the relevance of the entire section on U.S. dietary habits. These articles focus on the personal health aspects of the typical American diet—high fat, high cholesterol, low fiber, too many chemicals—rather than on the role U.S. consumption patterns play in affecting what is produced, and at what price, in the rest of the world. These articles, like the one in the "Population" section on compulsory sterilization of mental incompetents in the United States, raise issues of great social significance but have little bearing on the food and nutrition situation in the developing world. If articles concerning only the United States were to be included in this book, I would have preferred to see some discussion of the success and failure of U.S. efforts to alleviate poverty-related hunger and how these experiences might help in the design of programs in other countries.

U.S. agriculture, in contrast, has an obvious bearing on the world's food supply and distribution. In the section dealing with this subject, issues of technology and long-term resource use are addressed. Missing from this section was any discussion of the central role which U.S. farm price policies play in generating surpluses which can undermine world prices, possibly inhibiting the development of agriculture in the third world. The United States is a dominant force in world food markets; this role is probably more relevant to a book on world food and development than is the question of relative returns to organic and conventional farming in the United States, or the use of USDA surplus cheese in pizza.

Perhaps the most disappointing section of this book is the one that deals with solutions. These articles (or excerpts) are generally too short to present serious approaches to dealing with world development and the world food situation. (One exception, Streeter's interesting multiple-cropping article, left me wondering where that approach had been tried and whether it had been successful.) Poleman's too-short excerpt mentions briefly the "politically painful...pricing and investment decisions" which may be requisite to expanding food production. A more detailed discussion earlier in the book of what these decisions are (e.g., allowing food prices to fluctuate with supply; reducing untargeted and luxury subsidies; undermining the existing power structure by expanding access to farm credit), and why they might be necessary, would be helpful in understanding this reference. Similarly, an *Economist* article on Africa mentions the importance of exchange rates in determining the economic health of nations. A fuller discussion of this absolutely central factor in economic development is much needed. The article on political action by Bread for the World presents suggestions for influencing U.S. legislators but does not explain what specific things one might influence them to do. The previous section on Development and Underdevelopment presents a litany of failures of interventions such as agricultural technology (high-yielding varieties) and po-

litical change (land reform). These articles leave the reader waiting for some more constructive concrete proposals for action, yet the "solutions" offered do not really satisfy that need.

This book of readings is varied and some of the articles are interesting. As a whole, though, the book is unsatisfying because it lacks depth of analysis, leaves out some essential elements, and unfortunately contents itself with posing questions about a field in which one could, at least provisionally, suggest some answers.

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Beatrice Lorge Rogers, Associate Professor, Tufts University School of Nutrition.

Review Essay

Diet, Health, with Consequences for U.S. Agriculture

The Best Medicine. The Complete Health and Preventive Medicine Handbook. 1985. Kurt Butler and Lynn Rayner. 770 pp. Harper and Row, New York. Paper $16.95.

The Pritikin Permanent Weight Loss Manual. 1982. Nathan Pritikin. 396 pp. Bantam Books, New York. Paper $3.95.

Nutrition in the Middle and Later Years. 1983. Edited by E. B. Feldman. 342 pp. John Wright Inc., Boston, MA.

Medical Aspects of Dietary Fiber. 1980. Edited by G. A. Spiller and R. M. Kay. 299 pp. Plenum Medical Book Co., New York.

The relation of diet to health constitutes a subject of widespread public interest in the U.S. at the present time and appears to bear major potential implications for the future of U.S. agriculture.

The notion that improved nutrition and health should be one of the principles governing agricultural policy has been accorded support in some quarters. Norway, for example, has adopted such an integrated policy and a number of other countries, both developed and developing, have discussed the possibilities for creation of an integrated food policy in accord with public nutritional needs. Emerging consumer concerns regarding the safety and quality of the food supply now contribute an important new dimension in respect to the evolving character of U.S. agriculture. In 1985, for example, the Food Marketing Institute reported that 73% of a random sample of U.S. consumers believed that pesticide residues in foods pose a serious hazard to food safety. Many actions of the U.S. government obviously have direct or indirect impact on food quality and safety.

A major part of the output of U.S. farms eventually finds its way, often after one or more intermediate processes, into the diet of U.S. citizens. It seems reasonable to believe, therefore, that agricultural planners and others interested in the future of U.S. agriculture might find it useful to devote some thought to the U.S. diet, and particularly to trends for change in that diet.

Important diet-related health matters appear to be involved here. Heart attack, stroke, diabetes and its complications, and cancer have all been exacting a heavy toll on our population, and citizens are being strongly advised from many sources that faulty diets are implicated as a causative factor. Our diets, we are told, typically contain too much fat, too much sugar, too many calories, too much salt, and too little fiber. Such advice comes to us from the American Heart Association and the National Institutes of Health, also from many health advisory columns in our daily newspapers and articles in popular magazines. The common American diet of bacon and eggs or syrup and pancakes for breakfast, followed by a cheeseburger, French fries, and a soft-drink at noon, and by steak, potatoes and gravy, and apple pie in the evening contributes, we are informed, to the health problems mentioned above.

Not all of us will change our diets greatly and rapidly in response to the above admonitions but some of us presumably will change to some degree; perhaps enough of us will change sufficiently to influence the overall demand for various kinds of food products. Random observations suggest, in fact, that changes may already be in progress. Salad bars, one notes, have appeared in many public eating places in the past five years. Some food supermarkets have been tailoring their marketing strategies strongly toward "healthful" foods at moderate prices, i.e. foods low in fat, sugar, calories, and salt, while the number of so-called "natural" food stores has increased. Recently, Safeway launched a major campaign related to beef produced without antibiotics and other growth regulators. The U.S. per capita consumption of beef, generally high in fat, has fallen markedly since 1978 (Wall Street Journal, Aug. 7, 1986). Consumption of chicken, lower in fat, has been on the increase. Per capita consumption of eggs continues to fall. Production of fish, generally low in fat, has increased greatly in pond culture in the Mid-South. "Eat light" has become a popular idea. Even beer of lower calorie content seems to be in favor.

Four books relevant to these matters are reviewed briefly here. The first two are written expressly for the layman. The third and fourth are primarily for the health professional but contain major segments understandable to the layman also. All involve the effects of diet on health. All recommend dietary change.

1. **The Best Medicine.** The Complete Health and Preventive Medicine Handbook. Kurt Butler and Lynn Rayner.

Many books published within the past 5 years point to the relation of dietary factors to the above-mentioned health problems, i.e. to atherosclerosis, high blood pressure, and obesity--and eventually to heart attack and stroke, to diabetes (along with accompanying eyesight impairment and severe circulatory problems), and to cancer. The Butler-Rayner book, however seems to be superior to most of the others in several respects. It is comprehensive, exceptionally well organized, unusually lucid, and strongly fortified with factual evidence. As the title indicates, it places strong emphasis on preventive measures. Its judgments and recommendations are carefully written. It avoids medical jargon. The section on fad diets is forthright and detailed. The index is excellent. The authors do not leave the reader with the difficult task of integrating the diet-health matter into a broad general background of medical information. They do it for him. The book provides a good orientation in its title subject and an introduction to other books which discuss some of the same diet-health problems in greater detail.

2. **The Pritikin Permanent Weight Loss Manual.** Nathan Pritikin.

This is a best-seller which has probably influenced many people toward dietary change. It is much broader in content than its title might suggest. In terms understandable to the layman, it covers the gamut of dietary effects on atherosclerosis, high blood pressure, and obesity, and the many serious related health consequences. It offers many specific recommendations for dietary change, all woven together in a well organized fashion and in a highly readable style.

In the background of the book and obviously much involved in the choice of items of content is the fact that Nathan Pritikin had several "longevity centers" where he taught people--mostly middle-aged people and senior citizens--the essentials of his diet-exercise program. His diet, unlike many others offered to the public in book form, appears to enjoy rather wide approval from nutritionists. It differs from the others by its extraordinarily low level of allowable fat; Pritikin defends this feature vigorously and the reviewer finds his arguments convincing.

Individuals also interested in interactions of diet and exercise in relation to risk of heart attack may wish to follow with a reading of the same author's book "Nathan Pritikin Diet for Runners" (Simon and Schuster, New York). Much confusion has attended widely publicized incidents in which runners have died of heart attack, this to the consternation of exercise advocates. Pritikin analyzes many runner deaths individually, notes that autopsy very regularly has revealed atherosclerosis in the coronary arteries. He considers that faulty diet was crucial, had counteracted the undoubtedly beneficial effect of the running.

3. **Nutrition in the Middle and Later Years.** E. B. Feldman.

Many of the persons with strongest motivation toward dietary change are individuals concerned about one of the above-mentioned health problems so common in the middle and later years. There are many such people. Their problems are discussed in this book. It is a major reference resource written primarily for the use of the health professional and couched in major degree in the language of nutritional science and medicine. Much of it, however, will prove understandable to the layman. Each of its sixteen chapters covers a particular area of subject matter under the general title subject and is written by one or more experts. Subjects treated include nutrition and obesity, nutrition and cancer, nutritional factors in cardiovascular disease, nutrition and gastric intestinal tract disorders, renal problems in relation to nutrition, neurological manifestations of nutritional deficiencies, and a chapter on quackery and fad diets. Economic and sociological factors relevant to diets commonly consumed by seniors are separately and well treated. Superior organization and a good index make information on specific subjects easy to locate.

4. **Medical Aspects of Dietary Fiber.** Edited by G. A. Spiller and R. M. Kay.

The recent enthusiasm for high-fiber diets in the U.S. seems to have originated principally from the observation of one Denis Burkitt that many diseases common in western cultures, e.g. colon cancer, diverticulosis, and appendicitis, are rare or unknown in Third World countries, where diets are much higher in fiber. Burkitt reviews the evidence in a short chapter in this book. Has this idea been misinterpreted and exaggerated in its health implications by the U.S. food industry in pursuit of sales? Or is there substantial evidence behind it?

The Spiller-Kay book makes it evident that diets higher in fiber than the conventional high fat-high sugar diet common in the U.S. have, in fact, been found in dietary trials to facilitate the avoidance and/or therapeutic alleviation of several health problems. Blood glucose regulation in diabetics is often improved materially. The painful symptoms of diverticulosis are often much alleviated. Risk of colon cancer may perhaps be decreased, although this result may not occur specifically as a result of high fiber content but because of the low level of accompanying fat. -- *P. B. Marsh, Consultant, Institute for Alternative Agriculture, Greenbelt, MD.*

Compendium of Corn Diseases. 1980. Edited by M. C. Shurtleff. 105 pp. American Phytopathological Society, 3340 Pilot Knob Road, St. Paul, MN 55121.

This is one of a series of compendia on diseases of important plants, each published in an individual volume of about 100 pages at intervals in the period from 1977 to 1984. Presented in individual volumes are compendia on alfalfa, barley, beet, corn, cotton, elm, pea, peanut, potato, rose, sorghum,

soybean, strawberry, turfgrass, and wheat. We discuss the series here, with a few comments on individual volumes later.

The subject matter in the several volumes relates to diseases caused by biotic agents (bacteria, fungi, viruses, nematodes) and those caused by abiotic agents (agrichemical injury, frost and hail damage, nutrient deficiencies and imbalances, etc.). Information on diseases caused by biotic agents includes symptomatology, life cycle of the causative agent, epidemiology, and methods of control, all profusely illustrated. Resistant varieties, methods of exclusion of the pathogen, the relation of disease development to weather factors, and techniques of combatting secondary spread are all discussed. Diseases caused by abiotic agents are described in similar detail.

This series is intended principally for use by plant pathologists and extension personnel but will be to a major extent understandable by other interested individuals. The text is written in the terminology of plant pathology but there is a glossary in each volume which makes for a degree of usefulness to growers and others who may lack formal training in plant pathology. Each volume is prepared by a panel of experts. The text is in all cases written in a carefully organized fashion. In combination with an excellent index, this makes particulars of information easy to locate.

A consistent feature throughout the series is the excellence of the illustrations, which include many superb photographs and drawings, all carefully aimed toward elucidation of the subject. Each phase of the subject matter is supplemented with a few selected references to guide the reader into the literature of the subject. The text is in easy-to-read print on a high quality of paper, resulting in a durable and highly attractive volume. The individual volumes are available at a very moderate price from the American Phytopathological Society at the above address. Comments on a few items selected at random from the series may provide the reader with some insight into the kinds of subject matter involved.

Following an earlier edition, the Compendium of Corn Diseases was revised and published in a second edition in 1980. Its illustrations in colored photographs are dramatically excellent throughout. Photos are presented to illustrate not only the disease symptoms associated with fungal, bacterial, and viral diseases but also the leaf symptoms characteristics of nutritional deficiencies, e.g. deficiencies for N, P, K, and Mg.

The Compendium of Peanut Diseases begins with a general account of quantities of peanuts produced in various areas around the world and a description of the general structure and mode of growth of the plant. The plant is afflicted with a large number of diseases. About 50 genera of fungi alone have been shown to cause diseases in it. Peanut rust has increased in importance in recent years.

The Compendium of Potato Diseases features a discussion at an early point in the volume of oxygen-temperature relations of the tuber. This structure has high respiration rates at temperatures of 0-5 C, lower rates at 5-15 C, and then increasingly higher rates as the temperature increases to 25 C. The high respiration rates at low temperatures are associated with internal discoloration of the tuber. High respiration in packaged tubers during transit may deplete O_2 and release CO_2 in sufficient concentration to predispose them to bacterial soft rot. Effects of zinc deficiency and of numerous fungal and viral diseases are discussed and illustrated.

The Compendium of Soybean Diseases reveals that the soybean is affected by serious diseases caused by several different bacteria, fungi, viruses, and nematodes. Bacterial blight occurs in growing areas around the world. It forms conspicuous lesions on the leaves which enlarge in cool rainy weather and coalesce to produce large irregular dead areas. Control is by avoiding susceptible varieties, planting seeds relatively free of the pathogen, and rotation with plants not susceptible to the pathogen.

The Compendium of Strawberry Diseases reveals that this plant is affected not only by numerous biotic agents but can also show disease symptoms in response to saline soil, nutrien deficiencies, water-logged soil, an drought. Some idea of the magnitud of the effort involved in the compen dium series may be derived from th fact that 36 researchers wrote section of this manuscript or contributed pho tographs to it.

The Compendium of Wheat Dis eases begins with a highly useful ke to diseases of the plant. It is based o symptoms and indexed to the relevan text. In the table of contents of th volume, diseases are grouped accord ing to the part affected, i.e. disease with symptoms principally on seed an heads, diseases with symptoms prin cipally on foliage, and those wit symptoms principally on the roots each of these three groupings corre sponding to a major section in the tex of the volume. Viral diseases and thei vectors are discussed in detail.

These compendia will interest an be useful to field-oriented plant pa thologists and to many others con cerned in a practical way with th problems of plant disease. It should b understood, however, that the presen tation is not and is not intended to b encyclopedic nor exhaustive in its de tail. It has been streamlined by inten tional avoidance of many bypath along the way. While the microscopi aspects of many pathogens are show in detail, peripheral matters on detail of nutrition of the same organisms ha been largely avoided. While varieta differences in host resistance ar plainly indicated where practically im portant, detailed plant genetics i largely left out. Nomenclature of th pathogen is discussed where necessar to elucidate the overall subject but no otherwise. Clarity has been enhance by omission of less important detail.

Members of the American Phyto pathological Society involved in th preparation of this series of compendi have obviously been in substantia agreement on the purposes of the en deavor and have pursued their goals i good cooperation. The result to dat has been excellent and one can hop that future years will see a continuatio of the series. -- *P. B. Marsh, Consultan Institute for Alternative Agricultur Greenbelt, MD.*

IAA will publish extension newsletter

The Institute for Alternative Agriculture will begin publishing a special edition of *Alternative Agriculture News,* its monthly newsletter, for distribution to the nation's 3,000 county extension directors and area specialists. A grant from the Ruth Mott Fund is underwriting publishing and mailing costs for one year.

Garth Youngberg, IAA's Executive Director, said a growing number of extension personnel have become newsletter subscribers and at least one state extension office is sending the newsletter to all its county offices. Extension workers are getting a lot more questions from farmers about alternative production methods, he said, and often don't know where to go to obtain reliable information.

"The special edition will carry less policy-related material and more information on research reports and other published resources, on field days and other alternative agriculture events, and on educational initiatives taken by land grant universities and other institutions," he explained. "The emphasis will be on providing specific information, including addresses and phone numbers, that will enable extension personnel to follow up directly on things that interest them."

Youngberg said an editorial advisory group will provide a continuing review of the special edition. The members are Frank Brewer, Assistant Director of Extension Agricultural Marketing Programs at Michigan State; Martin Culick, Crops and Soils Agent with the Wisconsin Extension Service; Jerry DeWitt, Associate Director of the Iowa Extension Service; Charles Francis, Extension Crops Specialist at the University of Nebraska at Lincoln, and Dave MacNiel, Integrated Pest Management Program Leader of USDA's Extension Service.

Also Paxton Marshall, Virginia Extension Service Economist; James F. Parr, National Program Leader in Dryland Agriculture and Soil Fertility at USDA's Agricultural Research Service; Neill Schaller, Assistant Director of the Natural Resource Economics Division at USDA's Economic Research Service; Richard Weismiller, Soil and Water Resource Specialist with the Maryland Extension Service, and Ronald E. Voss, Program Director and Extension Vegetable Specialist at the University of California at Davis.

Edens and Parr are book review co-editors

Thomas C. Edens, a Michigan State University economist, has accepted an invitation to serve as a book review editor for the *American Journal of Alternative Agriculture.* He will serve as co-editor with James F. Parr, an Agriculture Research Service soil scientist.

Editor Garth Youngberg said Edens will cover books related to alternative agriculture in the social science field and Parr will cover books of this kind in the physical sciences and in international development. Parr has been book review editor since the journal began publication.

"The interdisciplinary character of the journal requires that books from a broad cross section of the agricultural sciences be considered for possible review," Youngberg said. "The rapidly growing number of books from diverse disciplines germane to alternative agriculture has made it necessary to have co-editors to share the workload."

Edens and Parr also are members of the journal's editorial board.

1986 IAA Symposium Proceedings Available

The proceedings of the Institute for Alternative Agriculture's third annual scientific symposium, a 60-page collection of edited papers dealing with biotechnology, are available.

Authors of the published papers are William Brown of Pioneer Hi-Bred International; Frederick H. Buttel and Randolph Barker of Cornell; Holly Hauptli and Robert M. Goodman of Calgene, Inc.; Richard Lower of the University of Wisconsin; Sue Tolin of Virginia Polytechnic Institute and State University; Jack Doyle of the Environmental Policy Institute, and David Bezdicek of Washington State.

Copies of *Biotechnology in Agriculture: Implications for Sustainability* are available for $6 postpaid from IAA at 9200 Edmonston Rd., Suite 117, Greenbelt, MD 20770. Edited tapes of the 1986 symposium also are available from IAA. The set of two cassettes is $7.50 postpaid.

IAA Board holds biannual meeting, elects new member

The third biannual board meeting of the Institute for Alternative Agriculture was held at Wolfe's Neck Farm near Freeport, Maine, on September 9

and 10. The board reviewed the Institute's staffing and funding needs and priorities in relation to both short- and long-term program development. Maureen Hinkle, Director of Agricultural Policy at the National Audubon Society, was elected to a 3-year term on the Board. Garth Youngberg, Executive Director, reported that reactions to the *American Journal of Alternative Agriculture* are very positive and that subscriptions are running ahead of projections.

Wolfe's Neck Farm, the site of the meeting, is a 600-acre organic beef operation which IAA board member Mrs. Lawrence M.C. Smith donated in 1984 to the University of Southern Maine to ensure that the goals of resource conservation, land preservation, and organic agriculture will be enhanced in the future. The farm continues under the management of Charles DeGrandpre, but allows students and scientists from the University of Maine at Orono to study alternative production methods on its land. The University of Southern Maine uses the property for a variety of programs, including institutes and seminars.

On the evening of September 9, some 40 guests, including representatives and officials from the University of Southern Maine, the University of Maine at Orono, the Maine Organic Farmers and Gardeners Association, and a number of resource conservation and land preservation groups, had an opportunity to meet informally with IAA board members at a reception hosted by Mrs. Smith.

1987 IAA Symposium will focus on water quality

The connection between agricultural production practices and groundwater contamination will be explored at the fourth annual scientific symposium presented by the *Institute for Alternative Agriculture*. The one-day event will be held next March 3 in Washington.

Garth Youngberg, IAA's Executive Director, said the symposium will document the nature and extent of the nation's growing groundwater pollution problem. "It is now widely agreed that chemical pollution of this water resource has been accelerated by modern chemical- and energy-intensive farming practices," he said. "The massive shift in recent years away from soil-conserving crop rotations to chemical-intensive monocultural cash grain systems has contributed significantly to this problem."

The symposium, Youngberg emphasized, will present a full range of constructive and workable management alternatives for solving the problem within the context of modern production agriculture. "Although the regulation of harmful agricultural chemicals will be considered, this symposium will go beyond the usual call for more and better regulation," he said. "It also will discuss the possible contribution of economically-viable low-input production systems that avoid entirely, or largely exclude, the use of agricultural chemicals."

Symposium participants will address three central questions: (1) How bad is the problem of agriculture-related groundwater contamination?; (2) From a technical perspective, how far can this nation's agriculture go in avoiding the use of agricultural chemicals?; and (3) What research, education, and other public policies are needed to achieve these objectives?

Youngberg reported that participation by several speakers has been confirmed. George Hallberg, Chief, Geological Studies, Iowa Geological Survey, will present the keynote address. Robert Papendick, chairman of the 1980 USDA organic farming report, will present a paper on soil and water management strategies and cropping systems that can help avoid the use of agricultural chemicals. Papendick is research leader of the USDA-ARS Land Management and Water Conservation Research Laboratory at Pullman, Washington.

Other confirmed speakers includ Charles A. Francis, Professor o Agronomy and Extension Crops Spe cialist, University of Nebraska, Lin coln, and Professor Lawrence Libby an agricultural economist at Michiga State University. Francis will outlin the education and technology transfe requirements for the widescale adop tion of alternative farming methods Libby will explore the behavioral an social science dimensions of ground water contamination. In addition t the keynote address, four major panel are being planned. One panel will fea ture presentations by both organic an conventional farmers.

1987 Fellowship program announced

The National Center for Food and Agricultural Policy at Resources for the Future has announced that applications are available for its 1987 Leadership Development Program. Now in its second year, the program offers up to 25 fellowships to qualified young professionals from business, government, education, farming, and agricultural organizations. The four-week program, held in Washington early in the year, features specially designed seminars and workshops with experts on food and agricultural policy, plus meetings with key decision-makers. Each fellow also carries out a self-directed study of a policy topic. For more information and application materials contact: John J. Kornacki, National Center for Food and Agricultural Policy, Resources for the Future, 1616 P Street, N.W., Washington DC 20036. Phone (202) 328-5056.

IFOAM Conference focuses on sustainable agriculture systems in a global context

The sixth international conference of the International Federation of Organic Agriculture Movements (IFOAM) took place August 18-21 at the University of California at Santa Cruz, organized by that institution's Agroecology Program. Like its predecessors, this conference offered an overview of research and education around the world on low input, resource conserving, sustainable farming systems. IFOAM, with members from every continent and over 50 countries, is by far the largest and best known international organization in this field, and its conferences are the preeminent event of their kind. The Santa Cruz conference continued a series that began in Switzerland in 1977 and that has alternated between Western Europe and North America every two years since 1978.

The sixth IFOAM conference was the largest so far, with more than 150 speakers and an audience of over 400. Fulfilling its theme of "Global Perspectives on Agroecology and Sustainable Agricultural Systems," it also was the most international. Less than half the audience was from the United States, with 35 other countries also represented.

As might be expected with a program of this size, the conference ranged over every conceivable aspect of its broad theme. The papers covered agriculture in settings as geographically diverse as metropolitan America, tropical Mexico, and the highlands of central Africa. Many speakers dealt with well established crops, but others talked about new and unfamiliar crops that might improve the sustainability of agriculture in the future, while still others reported on traditional crops that have passed from the mainstream but that perhaps deserve renewed attention. Every phase of agricultural systems was considered, from production to marketing to consumption. While some speakers chose to present highly detailed discussions of techniques of pest control, soil fertility, or livestock management, others were concerned with social and economic issues or with broad philosophical and ethical principles of sustainable agriculture.

Besides the many papers by individual authors, there were several panel discussions on topics such as marketing organic produce, political action, and agricultural development. Most of the talks were offered in response to a broadly disseminated call for papers, but the program included three well-known invited speakers: Wes Jackson, Francis Moore Lappe, and Masanobu Fukuoka. The program was further varied by the inclusion of several videotapes and films. In addition, there was a diverse group of poster displays on research, development, and educational projects in many different countries. Particularly interesting was the half day tour of the Agroecology Program's field experiments, which investigate topics such as nitrogen fixation, intercropping and pest/predator/host plant interactions.

IAA and AJAA staff, board members, and editors were well represented on the program. Stephen Gliessman was one of the conference organizers and presented a paper. Warren Sahs, William Lockeretz, Katherine Clancy, Patrick Madden, Charles Francis and Miguel Altieri presented papers, and Garth Youngberg and David Bunn participated in a panel.

General Assembly elects board

Following the conference, IFOAM held its biennial General Assembly. A seven member Board of Directors was elected that included IAA president Warren Sahs, the only non-European member. The Board then reelected Engelhard Boehncke, of the University of Kassel, West Germany, as its Chairman.

In a break with an established pattern for conference sites, the Assembly decided to hold the seventh conference in the African country of Burkina Faso in 1988. The choice reflected IFOAM's ever-growing interest in agriculture in the developing world. Also, for the first time IFOAM will have a paid, full-time General Secretary. Bernward Geier, an agricultural researcher from West Germany will assume this position in February, 1987. Geier replaces Gunnar Videgard of Sweden who functioned effectively as IFOAM's General Secretary for the past several years on a volunteer basis.

Other events

Two other important events were held in conjunction with the conference. The first was an August 11-17 agricultural tour through northern and central California. It featured a number of farm visits, including specialty crop operations under organic management. The itinerary also included a stop at agricultural research facilities at the University of California at Davis. The final event was an August 25-30 short course in agroecology organized jointly by the Division of Biological Control at the University of California-Berkeley and the Agroecology Program at the University of California-Santa Cruz.

The sixth IFOAM conference reached a new level in the continuing trend towards greater size as well as greater diversity among both the audience and the speakers. Participants represented an ex-

UPCOMING EVENTS

Sept. 19-21. Tenth Annual Common Ground Country Fair sponsored by the Maine Organic Farmers and Gardeners Association at Windsor, Me. Contact MOFGA at P.O. Box 2176, Augusta, ME 04330.

Sept. 28-30. State of the Land Meeting sponsored by the American Land Resources Association in Chevy Chase, Md. Contact ALRA at 5410 Grosvenor Lane, Bethesda, MD 20814.

Oct. 16-17. Pesticides and Groundwater Conference sponsored by Freshwater Foundation and U.S. Environmental Protection Agency at St. Paul, Minn. Contact Freshwater Foundation, 2500 Shadywood Road, Box 90, Navarre, MN 55392.

Oct. 19-21. Sunrise Agriculture in the Northeast: Foundations of a Sustainable Agriculture for the 21st Century sponsored by the Maine Agricultural Experiment Station and the Maine Department of Agriculture at the University of Maine at Orono. Contact Mark W. Anderson, Maine Agricultural Experiment Station, 6 Winslow Hall, University of Maine, Orono, ME 04469.

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ceptionally broad range of geographic locations and virtually every aspect of involvement in both alternative and conventional agriculture, including production, research, teaching, extension, marketing, and administration. Like its predecessors, this conference testifies to the thriving worldwide interest in sustainable and environmentally sound agriculture. For more information on IFOAM's purposes, and its future program plans, conferences,publications, and membership categories, write: IFOAM Secretariat, 161, DOM. des Bois Mures, 06130 Grasse, France.

Oct. 24-26. Globescope II sponsored by the Lincoln Filene Center for Citizenship and Public Affairs and the Global Tomorrow Coalition in Medford, Mass. Contact Globescope II, Lincoln Filene Center, Tufts University, Medford, MA 02155.

Oct. 25-27. Natural Foods Expo '86 East sponsored by New Hope Communications in Washington. Contact Joanne Dusek, Natural Foods Expo '86 East, 328 South Main Street, New Hope, PA 18938.

Oct. 29-31. National Agricultural Forum: The Health of the Land and Its People sponsored by the Riley Memorial Foundation and the U.S. Department of Agriculture in Washington. Contact National Agricultural Forum, Riley Memorial Foundation, 25 West 43rd Street, Suite 907, New York, NY 10036.

Nov. 7. Farming for the Future: Making and Marketing the Transition in Fresno, Calif. The conference is sponsored by the Extension Service, Steering Committee for Sustainable Agriculture, California Association of Family Farmers, and California Certified Organic Farmers. Contact Small Farm Center, University of California, Davis, CA 95616.

Nov. 20-21. National Conference on Sustaining Agriculture Near Cities in Boston. Contact William Lockeretz, School of Nutrition, Tufts University, Medford, MA 02155.

Dec. 2-3. Agriculture Diversification Conference sponsored by *Successful Farming* in Des Moines. Contact Rich Krumme, Editor, *Successful Farming*, 1716 Locust St., Des Moines, IA 50336.

Jan. 30-Feb. 1. Annual Ecological Farming Conference sponsored by the Steering Committee for Sustainable Agriculture in La Honda, Calif. Contact Steering Committee for Sustainable Agriculture, P.O. Box 1394, Davis, CA 95617.

Mar. 3. Symposium on Pollution of Groundwater sponsored by the Institute for Alternative Agriculture in Washington. Contact IAA, 9200 Edmonston Road, Greenbelt, MD 20770.

April 27-29. The Role of Legumes in Conservation Tillage Systems sponsored by the Soil Conservation Society of America at Athens, Ga. Contact SCSA at 7515 Northeast Ankeny Road, Ankeny, IA 50021.

SPECIALIST IN SUSTAINABLE AGRICULTURE

University of California, Davis, is seeking a career track academic candidate to provide overall coordination of sustainability programs. Provide academic leadership for research, education, information and publicity in Coop. Ext. for ag production and marketing systems to provide short- and long-term sustainability. Also, interim coordination of small farm program. A combination of graduate education and experience in the social, biological or environmental sciences. Assure affirmative action in development and delivery of programs. Salary in the Associate/Full Specialist rank. **Contact Coop. Ext.** Personnel, Univ. of Calif., Berkeley 94720. 415/644-4320. Close 11/14/86. Refer to #A-86-070. Affirmative Action Equal Opportunity Employer M/F.H.

Guide for authors

AJAA will publish original research on biological, physical, r social science aspects of alternative agriculture. We par-icularly welcome multi-disciplinary studies, but papers from specific discipline also are invited. However, since AJAA eadership is much broader than for a single-discipline journal, ighly specialized terminology should be explained or avoided. he significance of a statement, or the reasoning behind a onclusion, may have to be spelled out more than in a more pecialized journal. Research papers usually should be no onger than about 20 double-spaced pages.

Nomenclature and technical details

Research papers should use the International (SI, or metric) ystem throughout. Write out "liters". "Metric ton", although ot strictly an accepted SI unit, can be used for data referring o "ordinary life," such as national crop output, as opposed o experimental data. Occasional use of common unit equiv-lents in parentheses is permitted, mainly for relatively exotic I units.

The binominal or trinominal designation of a plant or an-mal species, and the cultivar where relevant, should be given n parentheses the first time the common name of the species s mentioned. Either name may be used thereafter. The same pplies to names of chemicals that have both a common name nd a chemical name. Do not use brand names except where he chemical is produced under a unique brand name. In those ases the brand name, identified as such, may be given the irst time the chemical is mentioned. Nutrient applications hould be given in elemental form (N,P,K). Oxide forms can e used in describing commercial fertilizers.

Title page

The title page should give the following information (all lush left): 1) title of the paper; 2) names of authors; 3) af-iliation and office address of authors, and 4) acknowledge-ents, if any. See examples in this issue of AJAA.

Abstract

The abstract should be 200 to 400 words suitable for readers rom a broad range of disciplines. It should avoid highly-pecialized terminology that might be appropriate for a single iscipline journal. Take particular care that the significance f the work is made clear, even to readers from a different ield.

Reference list

References should be listed in alphabetical order by author's ame, and by year for a particular author (with letters after he year if needed). If a sole author is also the lead author of apers with multiple authors, use the following order: single uthor (by year); two authors (alphabetically by second author's name); three or more authors (by year). Repeat the author's name for each reference. Use initials only for first and middle names. Give the names of all authors in the reference; never use "et al."

Use full names of journals, institutions, conferences, etc., except for extremely familiar abbreviations like "Dept." Remember that an abbreviation familiar to you may not be familiar to readers outside your field. If in doubt, write it out.

The reference list uses no quotation marks, italics, boldface, or underlining. Only the names of books and periodicals are in initial capitals. Names of papers, book chapters, pamphlets, and bulletins are not capitalized. Page numbers are written out in full (e.g., 1108-1123, not 1108-23). The volume is given if page numbers begin at 1 for each issue.

Citing references

Cite references in the text by last name and year, with chapter or page numbers if the reference is a book or lengthy report. For two authors, give both names. Do not use "et al." unless there are at least three authors.

Footnotes

AJAA does not use bibliographic or substantive footnotes. All bibliographic references should be at the end of the text. Instead of substantive footnotes, include the material in the main text or consider eliminating it.

Manuscript preparation

The entire manuscript, including abstract and references, should be typed on one side of standard-size paper, double spaced, with margins of at least one inch all around. Starting with the title page, label all pages in the upper righthand corner with the lead author's last name and the page number. Do not use hyphens unless the hyphen is part of the word. Do not underline anything except species names.

Follow the section headings style used in this AJAA issue. All headings are flush left, with no underlining or italics.

Tables should fit on one page, be numbered consecutively with Arabic numerals, and be on a separate sheet. Leave extra space to separate columns. Every figure and table should be mentioned at least once in the text.

Submission of manuscripts

Submit four high-quality copies to Editor, American Journal of Alternative Agriculture, Suite 117, 9200 Edmonston Road, Greenbelt, MD 20770. The cover letter should state that the manuscript is an original contribution that has not been published elsewhere in substantially the same form; that it is not currently under consideration elsewhere, and that permission has been obtained for any copyrighted material used.

How you can help support the scientific and educational needs of a sustainable agricultural system

A growing number of Americans have become concerned about the long-term sustainability of our food production system. Farmers and agricultural scientists are among those raising questions about the growing dependence of modern farming on nonrenewable resources, the depletion of our resource base through soil erosion, and heavy reliance on chemical fertilizers and pesticides. Continued heavy reliance on farm chemicals is questioned because they have become an expensive production input. Their widespread use also raises questions about human and animal health, food quality and safety, environmental quality, and the continued demise of the family farm.

Low-input alternative farming methods address these economic and environmental challenges. Alternative production systems point the way toward more profits, more individual choice, and long-term sustainability for our food system. More must be done to develop effective ways to make sure research, education, and information sources are readily available to farmers who want to adopt these techniques.

The Institute for Alternative Agriculture needs your help in meeting this challenge. We are a nonprofit tax-exempt research and education organization set up in 1983 to encourage and facilitate the adoption of low cost, resource conserving, and environmentally sound farming methods. We work directly with government agencies, colleges and universities, producer groups, and other institutions that provide research, education and information services to farmers.

The Institute also provides these services:

- *A resource to lawmakers and others who influence agricultural research, education, and information policy*
- *A voice for alternative agriculture in Washington*
- *A sponsor of research and education outreach programs*
- *A national clearinghouse for information on alternative agriculture*
- *A publisher of reliable scientific information on agricultural sustainability*

If you're interested in helping us, please contact our office at 9200 Edmonston Road, Greenbelt, MD 20770. The phone number is (301) 441-8777.

INSTITUTE FOR
ALTERNATIVE AGRICULTURE, INC.